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(RESEARCH ARTICLE)

Awareness and acceptability of in vitro fertilization with preimplantation genetic diagnosis as a reproduction alternative for couples carrying the sickle cell gene

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Abstract

Background: There are numerous challenges associated with raising a child that have sickle cell disease (SCD). Invitro fertilization with pre-implantation genetic diagnosis (IVF w PGD) is a reproduction alternative that reduces the risk for giving birth to a child with SCD among at risk couples. However, awareness and acceptability of this option is largely unassessed in our environment.

Objective: To assess the awareness and acceptability of IVF w PGD as reproduction alternative for reducing the risk for giving birth to children with SCD among couples with children affected by SCD.

Materials and Methods: Seventy-three biological parents of children with SCD were interviewed with semi-structured questionnaire following consent at the Paediatric Haematology outpatient clinic of ESUT Teaching hospital Parklane, Enugu. Convenient sampling method was used. Data obtained was entered into SPSS version 26 and later exported to SPSS version 29 with which it was analyzed.

Results: Only 2 (2.7%) of the respondents were aware of IVF w PGD as reproduction alternative for reducing the risk for having a child with SCD among at risk couples. However, after education about the option it was acceptable to as many as 59 respondents (80.8%).

Conclusion: Awareness of IVF w PGD as reproduction alternative for reducing the risk of giving birth to children with SCD was abysmally low among the respondents however following education about the option acceptability was reasonably high. Increasing awareness about IVF w PGD is therefore hereby recommended as a strategy to reduce the burden of SCD in our environment.

Keywords: Sickle cell disease; Prevention; Preimplantation genetic diagnosis; Awareness; Acceptability

1. Introduction

Sickle cell disease (SCD) is a preventable but irreversible non communicable, genetically transmitted autosomal recessive blood disorder of significant public health importance in many parts of the world including but not limited to South America, the Caribbean, Central America, Saudi Arabia, India, Mediterranean, and especially in Sub Saharan Africa

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[1]. About 50 million people have been reported to be living with sickle cell disease globally with about 4-6 million of them in Nigeria [2]. Globally about 300,000 new SCD children are born annually with Sub Saharan Africa contributing more than half of the number [3]. Of this Nigeria accounts for 100,000-150,000 newborns with SCD annually, with annual infant death of 100,000 representing 8% of infant mortality in the country [4]. These figures corroborate reports that suggest Nigeria is the country with highest burden of SCD globally [5].

SCD is a significant contributor to morbidity and mortality in both pediatric and adult population. For example, about 50%-90% of children born with SCD in low- and low-middle-income countries of sub-Saharan Africa die before their fifth birthday [6]. Also, SCD contribute to several obstetric complications and hence contribute reasonably to morbidity and mortality among women of child-bearing age living with SCD especially in Sub Saharan Africa [7,8]. The survival advantage conferred by sickle cell trait against malaria parasite (Plasmodium falciparium) has been suggested by some report as a contributory factor for the high burden of SCD in Africa [9].

Parents go through a lot in the process of raising a child with sickle cell disease. The experience of parents of children with sickle cell disease is so challenging that some reports show that some of them refuse further child bearing for fear of the possibility of giving birth to another child with the disease [10]. For those of them who desire more children it may be logical to imagine that a common question on their lips would be what they could do to prevent their next child from having the disease. One of the answers to such question is conception via in vitro fertilization and embryo transfer with preimplantation genetic diagnosis (IVF w PGD) [11].

In vitro fertilization and embryo transfer with preimplantation genetic diagnosis entails ovarian stimulation, oocyte fertilization by in vitro fertilization (IVF), embryo culture, embryo biopsy, genetic analysis and embryo transfer to the uterus [11]. Preimplantation genetic diagnosis involves obtaining samples from oocytes or cleaving embryos for genetic analysis after in vitro fertilization [12]. Subsequently, only embryos that are free of the genetic disorders are made available for re-introduction into the uterus, in the hope of establishing pregnancy [13]. One major drawback against the use of IVF w PGD is the need for IVF even in couples that have no fertility problems. However, in settings where abortion laws are restrictive as in Nigeria, IVF w PGD appears to be the only option for reducing the risk of giving birth to a child with sickle cell disease among couples at risk who desire conception with their own gametes.

Despite the significant amount of resources needed for IVF w PGD Joshua et al reported that compared with the cost of life time standard of care for an affected individual, IVF w PGD is the most cost-effective strategy within the United States health sector for ~~the~~ managing the economic burden of sickle cell disease [14]. This huge potential benefit notwithstanding, the awareness as well as acceptability of this all-important intervention is largely unevaluated in our environment. The purpose of this study was to assess the awareness and acceptability of invitro fertilization with preimplantation genetic diagnosis among parents of children with SCD accessing care at ESUT Teaching hospital Parklane, Enugu as reproduction alternative to reduce the risk of having a child with SCD.

2. Materials and Methods

This study was part of a bigger study on reproduction alternatives for reducing the risk of giving birth to children with SCD among parents of children with SCD that accessed care at Paediatric haemataology outpatient clinic of ESUT Teaching Hospital Parklane Enugu during the study period. This was cross sectional study that spanned from 21st September, 2022 to 21st July, 2024. ESUT Teaching hospital is the second largest Teaching hospital in the state and is located in the center of Enugu Metropolis. It serves as a referral center for most states in the South East Nigeria. The department of Paediatrics is one of the four major departments of the hospital and Paediatric haematology clinic is one of the outpatient clinics in the department of Paediatrics. The Paediatric haematology clinic takes care of patients up to 18years of age and runs from 8:00 am in the morning to 4:00pm in the evening every Monday. The clinic is managed by a consultant paediatric haematologist, resident doctors, nurses and other allied health workers. Paediadtic Haematology outpatient clinic is a fairly busy clinic, however they also attend to other paediatric cases other than haematology cases.

The target population was biological parents of sickle cell disease children who received care at the outpatient clinic over the study period hence only biological parents of sickle cell children were included in the study. Written informed consent was obtained from all the respondents and they were reassured of the confidentiality of information provided. For each of the respondents, after the initial part of the questionnaire was administered to the point of assessing the awareness of IVF w PGD as reproduction alternative for reducing the risk of giving birth to children with SCD, he or she was given adequate counselling and education on IVF w PGD as a means for prevention of sickle cell disease before assessing the acceptability of IVF w PGD as reproduction alternative for reducing the risk of giving birth to children with SCD. Ethical clearance for the study was obtained from the ethics committee of ESUT Teaching hospital Parklane, Enugu.

A well-structured interviewer-administered questionnaire was used to obtain information on sociodemographic variables of the respondents, as well as their awareness and acceptability of IVF w PGD as a means to reduce the risk for giving birth to children with SCD. The questionnaire was pretested and all ambiguity removed.

Data collected was keyed into SPSS version 26 before it was exported to SPSS version 29. Subsequently, the data was subjected to data cleaning to ensure completeness and accuracy before analysis. Categorical variables, including awareness and acceptability of in vitro fertilization with pre-implantation genetic diagnosis (IVF with PGD) were summarized using frequencies and percentages to determine the proportion of parents who were aware of and accepted use of IVF w PGD. Continuous variables were described using the mean and standard deviation to provide insights into central tendency and variability.

Associations between variables were explored using Fisher's exact test for categorical variables. For continuous variables, the Mann-Whitney U test was employed to assess significant differences in medians across groups.

3. Results

A total of 73 respondents were interviewed. Out of these, 8 were males (11%) while 65 were females (89%). Sixty-two of the respondents (84.9%) were urban dwellers while 11 (15.1%) were from the rural areas. All the respondents except one were of the Igbo tribe and all the respondents were Christians (table 1). The rest of the sociodemographic characteristics are as shown on table 1 below.

Table 1 Respondents Characteristics

Respondents Characteristic	Frequency (n=73)	Percentages (%)
Age		
20 - <30 years	9	12.3
30 - <40 years	26	35.6
40 - <50 years	30	41.1
50 years and above	8	11.0
Sex		
Male	8	11
Female	65	89
Residence		
Rural	11	15.1
Urban	62	84.9
Tribe		
Igbo	72	98.6
Yoruba	0	0
Hausa	0	0
Others	1	1.4
Religion		
Christianity	73	100
Islam	0	0
African traditional religion	0	0
Others	0	0
Educational status		
No formal education	0	0
Primary education	6	8.2
Secondary education	36	49.3
Tertiary education	27	37

Postgraduate education	4	5.5
Occupation		
Unemployed	7	9.6
Trader	38	52.1
Artisan	9	12.3
Civil servants	14	19.2
Professionals	1	1.4
Others	4	5.5
Marital status		
Single	1	1.4
Married	64	87.7
Divorced	0	0
Separated	2	2.7
Widow	6	8.2
Widower	0	0
Duration/age of marriage		
Less than 5 years	7	9.6
5 – <10 years	19	26
10 – <15 years	19	26
15 – <20 years	13	17.8
20 years and above	14	19.2
Not applicable	1	1.4

Table 2 is a display of the family and reproductive history of participants. As is shown below, 17 (23.3%) participants had lost at least one child to SCD.

Table 2 Family and Reproductive History of Participants

Family and Reproductive History	**Mean**	**SD**	**Frequency (73)**	**Percentages (%)**
Number of children	3	1.729		
Number of children with sickle cell disease	1	0.430		
History of child death due to sickle cell disease				
Yes			17	23.3
No			56	76.7
If yes, how many				
1 child			13	76.5
2 children			3	17.6
3 children			1	5.9

Table 3 Awareness and acceptability of invitro fertilization and preimplantation genetic diagnosis as a reproduction alternative for reducing the risk of having a child with SCD

	Yes	**Percentage**	**No**	**Percentage**
Awareness of IVF w PGD as reproduction alternative	2	2.7	71	97.3
Acceptability of IVF w PGD as reproduction alternative	59	80.8	14	19.2

As shown in table 3, awareness of invitro fertilization with preimplantation genetic diagnosis as a reproduction alternative for reducing the risk of having a child with SCD among the respondents was low (n=2; 2.7%) while acceptability was high (n=59; 80.8%).

As shown in Table 4, none of the respondents' characteristics was significantly associated with awareness of invitro fertilization with preimplantation genetic diagnosis as a reproduction alternative for reducing the risk for giving birth to a child with SCD.

On the other hand, Table 5 shows that number of children of respondents that died from SCD was significantly associated with acceptance of invitro fertilization with preimplantation genetic diagnosis as a reproduction alternative for reducing the risk of giving birth to a child with SCD (*P = .047*).

Table 4 Relationship between awareness of IVF w PGD and respondents' characteristics

Respondents characteristics	**Awareness of IVF w PGD as reproduction alternative**				**P-value**
	No		Yes		
	Frequency	Percentage	Frequency	Percentage	
Age					
20 - <30 years	8	11	1	1.4	0.414
30 - <40 years	26	35.6	0	0	
40 - <50 years	29	39.7	1	1.4	
50 years and above	8	11	0	0	
Sex					
Male	8	11	0	0	1.000
Female	63	86.3	2	2.7	
Residence					
Rural	11	15.1	0	0	1.000
Urban	60	82.2	2	2.7	
Tribe					
Igbo	70	95.9	2	2.7	1.000
Others	1	1.4	0	0	
Educational status					
Primary education	6	8.2	0	0	1.000
Secondary education	35	47.9	1	1.4	
Tertiary education	26	35.6	1	1.4	
Postgraduate education	4	5.5	0	0	
Occupation					
Unemployed	6	8.2	1	1.4	0.121
Trader	38	52.1	0	0	
Artisan	8	11	1	1.4	
Civil servants	14	19.2	0	0	
Professionals	1	1.4	0	0	
Others	4	5.5	0	0	
Marital status					
Single	1	1.4	0	0	0.233
Married	63	86.3	1	1.4	

Separated	2	2.7	0	0	
Widow	5	6.8	1	1.4	
Duration of marriage					
Less than 5 years	6	8.2	1	1.4	0.273
5 – <10 years	19	26	0	0	
10 – <15 years	18	24.7	1	1.4	
15 – <20 years	13	17.8	0	0	
20 years and above	14	19.2	0	0	
Not applicable	1	1.4	0	0	
Number of children	71	97.3	2	2.7	0.836
Number of children that has SCD	71	97.3	2	2.7	0.242
Respondents whose children died from SCD					
Yes	17	23.3	0	0	
No	54	74	2	2.7	1.000
Number of children of respondents that died from SCD					
1	13	17.8	0	0	
2	3	4.1	0	0	1.000
3	1	1.4	0	0	
Not applicable	54	74	2	2.7	

Table 5 Relationship between acceptability of IVF w PGD and respondents' characteristics

Respondents' Characteristics	**Acceptance of IVF w PGD as reproduction alternative**				**P-value**
	No		Yes		
	Frequency	Percentage	Frequency	Percentage	
Age					
20 - <30 years	1	1.4	8	11	0.713
30 - <40 years	4	5.5	22	30.1	
40 - <50 years	8	11	22	30.1	
50 years and above	1	1.4	7	9.6	
Sex					
Male	3	4.1	5	6.8	0.175
Female	11	15.1	54	74	
Residence					
Rural	2	2.7	9	12.3	1.000
Urban	12	16.4	50	68.5	
Tribe					
Igbo	14	19.2	58	79.5	1.000
Others	0	0	1	1.4	
Educational status					
Primary education	2	2.7	4	5.5	0.470
Secondary education	5	6.8	31	42.5	
Tertiary education	6	8.2	21	28.8	

Postgraduate education	1	1.4	3	4.1	
Occupation					
Unemployed	0	0	7	9.6	0.097
Trader	7	9.6	31	42.5	
Artisan	0	0	9	12.3	
Civil servants	5	6.8	9	12.3	
Professionals	0	0	1	1.3	
Others	2	2.7	2	2.7	
Marital status					
Single	0	0	1	1.4	0.654
Married	14	19.2	50	68.5	
Separated	0	0	2	2.7	
Widow	0	0	6	8.2	
Duration of marriage					
Less than 5 years	1	1.4	6	8.2	0.428
5 – <10 years	1	1.4	18	24.7	
10 – <15 years	5	6.8	14	19.2	
15 – <20 years	4	5.5	9	12.3	
20 years and above	3	4.1	11	15.1	
Not applicable	0	0	1	1.4	
Number of children	14	19.2	59	80.8	0.869
Number of children that has SCD	14	19.2	59	80.8	0.688
Respondents whose children died from SCD					
Yes	6	8.2	11	15.1	0.067
No	8	11	48	65.8	
Number of children of respondents that died from SCD					
1	5	6.8	8	11	0.047*
2	0	0	3	4.1	
3	1	1.4	0	0	
Not applicable	8	11	48	65.8	

Table 6 Pattern of Reasons for Acceptance of IVF w PGD as a reproduction alternative for reducing the risk for giving birth to children with SCD among the respondents

Reason	**Yes**		**No**		**Not applicable**	
	Frequency	Percent (%)	Frequency	Percent (%)	Frequency	Percent (%)
Cultural belief	5	6.8	54	74	14	19.2
Societal acceptance	7	9.6	52	71.2	14	19.2
Desire for biological child	57	78.1	2	2.7	14	19.2
Nature of the process	13	17.8	46	63	14	19.2
Cost	8	11	51	69.9	14	19.2
Religious belief	9	12.3	50	68.5	14	19.2

Table 7 Pattern of Reasons for Non-acceptance of IVF w PGD as a reproduction alternative for reducing the risk for giving birth to children with SCD among the respondents

Reason	Yes		No		Not applicable	
	Frequency	Percent (%)	Frequency	Percent (%)	Frequency	Percent (%)
Cultural belief	1	1.4	13	17.8	59	80.8
Societal acceptance	1	1.4	13	17.8	59	80.8
Desire for biological child	4	5.5	10	13.7	59	80.8
Nature of the process	8	11	6	8.2	59	80.8
Cost	2	2.7	12	16.4	59	80.8
Religious belief	1	1.4	13	17.8	59	80.8

Finding in Table 6 above suggests that desire for biological children (78.1%) was the main reason for acceptance of invitro fertilization with Preimplantation diagnosis as a reproduction alternative by majority of the respondents (78.1%).

On the other hand, findings in Table 7 suggests that the commonest reason for non-acceptance among the few respondents that rejected invitro fertilization with preimplantation genetic diagnosis as reproduction alternative was the nature of the process (11%).

4. Discussion

Parents go through a lot in the process of raising a child with sickle cell disease. The challenges are so much that some affected parents, for fear of the possibility of giving birth to another child with SCD, have been reported to decide against further child bearing even when they desire more children [10]. As such, any intervention geared towards helping parents of children with SCD to minimize the risk of giving birth to more children with SCD will be a welcome contribution. In this regard, in vitro fertilization and embryo transfer with pre-implantation genetic diagnosis (IVF w PGD) has been identified as one of the most cost-effective interventions [14]. More importantly, IVF w PGD for now is the only option for reducing the risk for giving birth to a child with sickle cell disease for couples at risk who desire conception with their own gametes especially in settings with restrictive abortion law such as Nigeria [15,16]. According to Nzekwue and colleague awareness and uptake of IVF w PGD as well as studies assessing the trend in Africa has remained low [11]. Since the awareness and acceptability of IVF w PGD remains largely unexplored in our environment, this study assessed the awareness and acceptability of IVF w PGD as a reproduction alternative for reducing the risk for giving birth to a child with SCD among parents of children with SCD who visited the pediatric hematology outpatient clinic of our hospital during the study period.

Majority of the respondents were aged between 30 to 50 years, were females and from Igbo tribe. Majority of the respondents being females is in keeping with role expectations for parents in the study environment where mothers are expected to be and indeed are more involved with taking care of the children including accompanying the child to hospital while fathers are expected to be and indeed are more involved with economic activities in order to provide for the family [17]. This finding of majority of the respondents being female is similar to report from a related study done in South South Nigeria (respondents were 69.6% females) which evaluated the knowledge and acceptability of prenatal diagnosis among parents at risk of having another child with SCD [9]. Also, as in the above related study all the respondents in our study were Christians. This is most likely because South East Nigeria where this study was conducted like South South Nigeria is an area where Christianity is the dominant religion. All the respondents had some form of formal education with majority stopping at secondary and tertiary levels. Despite this, majority were traders while as much as 9.6% were unemployed. The challenges of raising children with SCD notwithstanding, as much as 87.7% of respondents had remained married with close to 20% of them having been married for twenty years or more. None of the respondents was divorced while only two were separated from their partners. The stability of the marriage of most of the respondents even in the face of challenges of raising a child or more with SCD may be related to their Christian faith since the teachings of Christian faith as well as Christian marriage vows state that marriage is 'for better; for worse' [18]. The respondents had an average of 3 children with an average of one child per respondent living with SCD. This is similar to report by Chioma in Port Harcourt, Nigeria [9]. The relatively small family size of the respondents in an

environment where so much premium is placed on child bearing like ours may have a bearing with restraint as a result of fear of having more children with SCD with the attendant challenges. As much as 23.3% of the respondents had lost at least one child to SCD while one of the respondents had lost three children. This appears to lend credence to the report that up 50-90% of children born with SCD in low and middle-income countries of sub-Saharan Africa die before their fifth birthday [6].

Awareness of IVF w PGD as reproduction alternative for reducing the risk of giving birth to children with SCD among at risk couples was abysmally low among the respondents in this study (2.7%). This is unfortunate considering the fact that since abortion law in Nigeria is very restrictive IVF w PGD appears to be the only reproduction alternative for a couple at risk of giving birth to children with SCD and who wish to achieve conception with their own gametes. Low awareness has also been reported in other related studies [9,11]. Relative higher percentage of respondents' awareness was reported by Darbari et al (44%) as well as Attia and colleagues (24%) [19,20]. Both studies were carried out in America hence environmental factors favoring easier access to health information may explain the relative higher awareness. On the other hand, acceptance of IVF w PGD as reproduction alternative for reducing the risk for giving birth to children with SCD among at risk couples was as high as 80.8%. Similarly, Darbari et al [19] reported that all the parents who wanted another child indicated readiness to use IVF w PGD while Attia and colleagues reported 91% acceptance [20]. Similarly high acceptance of IVF with PGD as a means to prevent SCD among parents of children with SCD appears to suggest that they have all been through lots of challenges hence their willingness to try the intervention as a way to prevent a repeat of their previous experience. High acceptance is encouraging since poor awareness which appears to be a major factor undermining the potential of IVF w PGD as a tool for reducing the prevalence of SCD is a challenge that can be addressed with relative ease. Of all the respondents' characteristics assessed, none was significantly associated with awareness of IVF w PGD as a reproduction alternative for reducing the risk for giving birth to children with SCD among at risk couples. However, acceptability was significantly associated with number of children of the respondents who have died from SCD. This is understandable since loss of one's child to SCD is more likely to make the respondents more eager to accept options for prevention.

Majority of the respondents gave desire for biological children as their reason for acceptance of invitro fertilization with preimplantation genetic diagnosis as a reproduction alternative for reducing the risk for giving birth to children with SCD. This is similar to report by Schultz and colleagues [10]. The commonest reason for non-acceptance among the few respondents that rejected IVF with preimplantation genetic diagnosis as a reproduction alternative was the nature of the process which requires prospective beneficiaries to conceive via invitro fertilization procedures whether they have fertility problem or not.

5. Conclusion

Though parents of children with SCD go through a lot in the process of raising affected children and some desire to have more but non-SCD children, the awareness of IVF w PGD as reproduction alternative for reducing the risk for giving birth to children with SCD among at risk couples is very low. However, following counselling and education on IVF w PGD its acceptance was very high hence the need for increased awareness of this cost-effective preventive measure. Relevant agencies including government agencies and policy makers, health agencies, religious organization, not-for-profit organizations, and community leaders as well as government policy makers should map out strategies for the education of the community about the availability of the IVF w PGD alternative. Also, government should make facilities that can offer such services to be readily available knowing the economic burden associated with raising children with SCD and the social challenges associated with not having children notwithstanding.

Compliance with ethical standards

Disclosure of conflict of interest

Authors declare no conflict of interest

Statement of informed consent

Authors declare that informed consent was obtained from all individual participants included in the study.

References

[1] Diwe K, Iwu AC, Uwakwe K, Duru C, Merenu I, Oguniyan T et al. Prevalence and Pattern of Sickle Cell Disease among Children attending Tertiary and non-Tertiary institutions in a South Eastern State, Nigeria: a 10-year survey. J Res Med Dent Sci. 2016; 4(3): 75-81.

[2] Nwabuko OC, Onwuchekwa U, Iheji O. An overview of sickle cell disease from the socio-demographic triangle - a Nigerian single-institution retrospective study. Pan Afr Med J. 2022; 41:161. doi: 10.11604/pamj.2022.41.161.27117.

[3] Mano RM, Kuona P, Misihairabgwi JM. Determination of birth prevalence of sickle cell disease using point of care test HemotypeSC™ at Rundu Hospital, Namibia. BMC Pediatr. 2024; 24(1):323. doi: 10.1186/s12887-024-04805-z.

[4] Yusuf MO, Shaibu PA, Imoudu IA. Knowledge, perception and acceptance of newborn screening for sickle cell disease among pregnant women in Bauchi, Nigeria. Niger. J. Paediatr. 2025; 52(2): 161-168.

[5] Ezenwosu, O.U., Olawepo, J.O., Lacroix-Willliamson, L.J. *et al.* Health education to promote knowledge about sickle cell disease and newborn screening in pregnant women: a community-based pilot study using the healthy beginning initiative. *BMC Pregnancy Childbirth* **24**, 321 (2024). https://doi.org/10.1186/s12884-024-06498-9

[6] Aygun B, Odame I. A global perspective on the sickle-cell disease. Pediatric Blood & Cancer. 2012; 59(2):386-390. doi:10.1002/pbc.24175.

[7] Ocheni S, Onah HE, Ibegbulam OG, Eze MI. Pregnancy outcomes in patients with sickle cell disease in Enugu, Nigeria. Niger J Med. 2007; 16:227-230.

[8] Ugboma HA, George IO. Sickle cell disease in Pregnancy, maternal and fetal outcomes in Port Harcourt, Nigeria. Niger J Med Res. 2015; 7:40-4.

[9] Chioma O. Prenatal diagnosis in sickle cell disease: in the eyes of the couple at risk. JAMMR 2020; 32(10): 65-71. Doi: 10.9734/jammr/2020/v32i1030520.

[10] Schultz CL, Tchume-Johnson T, Jackson T, Enninful-Eghan H, Schapira MM, Smith-Whitley K. Reproductive intentions in mothers of young children with sickle cell disease. Pediatr Blood Cancer. 2020; 67(5):e28227. doi: 10.1002/pbc.28227. Epub 2020 Feb 17. PMID: 32065500.

[11] Nzekwue C, Ogueh O. Prenatal diagnosis and preimplantation genetic diagnosis for sickle cell disease in Africa. Journal of Global Medicine. 2023: DOI: 10.51496/jogm.v2.75

[12] Brezina PR, Brezina DS, Kearns WG. Preimplantation genetic testing: clinical review. BMJ 2012; 345: 1-8. Doi: 10.1136/bmj.e5908

[13] Braude P, Pickering S, Flinter S, Ogilvie CM. Preimplantation genetic diagnosis. Nat Rev Genet. 2002; 3: 941-53. Doi: 10.1038/nrg953

[14] Combs JC, Dougherty M, Yamasaki MU, DeCherney AH, Devine KM, Hill MJ, Rothwell E, O'Brien JE, Nelson RE. Preimplantation genetic testing for sickle cell disease: a cost-effectiveness analysis. F S Rep. 2023; 4(3):300-307. doi: 10.1016/j.xfre.2023.06.001. PMID: 37719105; PMCID: PMC10504548.

[15] Okagbue I. Pregnancy termination and the law in Nigeria. Stud Fam Plann. 1990; 21(4):197-208. PMID: 2219225.

[16] Akande OW, Adenuga AT, Ejidike IC, Olufosoye AA. Unsafe abortion practices and the law in Nigeria: time for change. Sex Reprod Health Matters. 2020; 28(1):1758445. doi: 10.1080/26410397.2020.1758445. PMID: 32458762; PMCID: PMC7888045.

[17] Onwuatuegwu I. The notion of family in Igbo African society: a philosophical appraisal. EJPCR. 2020; 4(1): 17-25.

[18] Michael A. Goodman, "The influence of Faith on Marital Commitment," in By Divine Design: Best Practices for family Success and Happiness, ed. Brent L. Top and Michael A. Goodman (Provo, UT: Religious Studies Center; Salt Lake City: Deseret Book, 2014), 23-50.

[19] Darbari I, O'Brien JE, Hardy SJ, Speller-Brown B, Thaniel L, Martin B, Darbari DS, Nickel RS. Views of parents of children with sickle cell disease on pre-implantation genetic diagnosis. Pediatr Blood Cancer. 2018 Aug;65(8):e27102. doi: 10.1002/pbc.27102. Epub 2018 Apr 18. PMID: 29667775.

[20] Attia M, Kripalani S, Darbari I, Nickel RS. Parents of Children with Sickle Cell Disease Are Interested in Preimplantation Genetic Testing. J Pediatr. 2020 Aug; 223:178-182.e2. doi: 10.1016/j.jpeds.2020.04.027. Epub 2020 Jun 22. PMID: 32586619.