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ORIGINAL ARTICLE

Population With Genetically Correlated Monogenetic Problems of Durg District 0f Chhattisgarh, India.

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ABSTRACT
Sickle cell anemia and glucose – 6 – phosphate dehydrogenase (G6PD) deficiency are two major genetic health problems in many states of India including Chhattisgarh. Present work was undertaken to determine frequency of G6PD deficiency among sickle cell anemia patients and to establish correlation between both monogenetic disorder among target population for study of future course of management. Total 1,091 samples from four villages of Durg district of three different age groups i.e. 10-20, 20-30 and 30-40 years were analyzed. Frequency of sickle cell anemia was determined by slide test followed by electrophoresis and G6PD deficiency by methemoglobin reduction test. Correlation among both diseases was analyzed by Karl Pearson's Correlation Coefficient. Overall frequency of sickle cell anemia and G6PD deficiency among sickle patients was reported 5.13% and 23.21% respectively. A high degree of positive correlation between sickle cell anemia and G6PD deficiency was reported from three villages of Durg district (Jamgaon- r=0.86; Belaudi- r=0.94; Thanod- r=0.94) and low degree of negative correlation was reported from one village (Khapri- r= -0.49) The study makes possible the successful management and control of genetic diseases.
Keywords: Sickle cell anemia, Glucose-6-phosphate dehydrogenase, Correlation etc.

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INTRODUCTION

Sickle cell disease (SCD) is a single gene haematological inherited disorder results from inheritance of two copies of mutated variant of β-globin gene. It is common in individuals of African, Arabian and Indian origin [1]. SCD is caused due to point mutation at 6th position of β-globin chain which results in replacement of glutamate by valine and ultimately it leads to misshapen RBC [2].

Inheritance of sickle cell anemia (SCA) occurs by an autosomal recessive gene and clinical symptom appears only in individuals with homozygous (HbSS) condition [3]. Decreased expression of HbSS during fetal life is due to production of increased level of HbF. Thus clinical symptom begins to appear after six months of birth, when there is reduction in level of HbF [4]. SCD leads to polymerization of RBCs and thus it becomes rigid, sticky and becomes sickle shaped and these RBC causes obstruction in blood flow. The two major symptoms of SCD are severe anemia and vaso-occlusion crisis. Pain is typically caused by vaso-occlusion crises (VOC) which is the hallmark of SCD. Hypoxia, ischemia and intolerable painful episodes are results of SCD [5]. Sickle cell traits are generally asymptomatic but exposure of carriers to stressed condition shows various medical conditions like hematuria, splenic infarction, hyposthenuria etc [6].

In India, the disease was first detected in 1952 among residential tribes of Nilgiri hills of South India. Central and Western region of India has high prevalence of sickle cell trait as well as disease [7]. Affected gene is distributed mainly in Madhya Pradesh, Chhattisgarh, Maharashtra, Odisha, Tamil Nadu, Kerala etc [8].

According to a report of Jawahar Lal Nehru Memorial Medical college, Raipur, in Chhattisgarh, 10% of total population are affected with sickle cell disease among which tribal population are common

sufferers. According to Dr. A. R. Dalla – former Chairman of Indian Red Cross Society, Chairman Sickle Cell Organization of India – per year 10,000 children die of sickle cell in Chhattisgarh state. In a report released in December, 2017 by State Health Resource Centre, Raipur, 20% of Gond tribes suffers from sickle cell disease while 22% of prevalence rate reported from Sahu and Kurmi population. State govt. of Chhattisgarh has also started various initiatives to control sickle cell anemia in collaboration of SHRC, C.G. and TISS, Mumbai [9].

Another single gene disorder is G6PD deficiency which is the most common X-linked enzymopathy affecting approximately 400 million people worldwide leading to acute haemolytic anemia [10]. It plays important role in maintenance of reduced glutathione which protects cell from damage due to oxidative stress. G6PD is especially important in RBC's because in RBC, G6PD enzyme is the only source that can generate NADPH [11]. Deficiency in G6PD shows polymorphism in malaria endemic regions. Frequency of prevalence of G6PD deficiency is 2.3% – 27% in India while it is reported 7.7% in tribal communities. More than 10 percent of Gd^- genotype reported from tribal communities of different states i.e. Nagaland, West Bengal and Chhattisgarh while it is less than 10 percent in the states like Himachal Pradesh, Uttarakhand, Andhra Pradesh and Madhya Pradesh [12].

Although a lot of studies regarding prevalence and association of sickle cell anemia and G6PD deficiency have been carried out in national as well as international level, limited reports regarding its prevalence and association are available for Chhattisgarh. Thus present study was carried out in Sahu and Kurmi community of Durg district to determine the frequency and correlation among both diseases i.e. Sickle cell anemia and G6PD deficiency.

MATERIAL AND METHODS

Present study was carried out in Sahu and Kurmi community from four villages (Jamgaon R, Khapri, Belaudi and Thanod) of Durg district of Chhattisgarh, India. Total 1,091 blood samples were collected for analysis after approval from Institutional Ethical Committee. Collected samples were sub-divided into three different age groups (10-20, 20-30 and 30-40 years).

Selection of population and area: Chhattisgarh state is also known as state of tribal communities as well as Sahu and Kurmi communities are native community of the state and consanguineous marriage is common phenomena among some communities which restrict the diversification of gene thus adversely affecting these communities. For this reason Sahu and Kurmi community of Durg district was selected for study.

Screening of Sickle Cell Anemia and G6PD deficiency: Total 1,091 samples were screened for detection of sickle cell anemia and G6PD deficiency. Two ml intravenous blood sample was collected and subjected to sodium metabisulphite slide test followed by Cellulose Acetate Paper Electrophoresis for detection of HbAS and HbSS while G6PD deficiency was detected by methemoglobin reduction test.

Statistical validation of data: Correlation between G6PD deficiency and sickle cell anemia was established by Karl Pearson's Correlation Coefficient.

RESULTS

High frequency of both sickle cell anemia and G6PD deficiency was reported in Sahu and Kurmi community from four different villages (Jamgaon R, Khapri, Belaudi and Thanod) of Durg District of Chhattisgarh, India. Total 4.53%, 5.23%, 6.01% and 4.90% were found suffering from sickle cell anemia (Fig 3) and 21.4%,18.18%, 25.0% and 26.6% sickle patients were reported with G6PD deficiency from Jamgaon R, Khapri, Belaudi, Thanod respectively (Table 1-4; Fig 1(a-b); Fig 2; Fig 4). A high degree of positive correlation between sickle cell anemia and G6PD deficiency was also reported in our study except in village Khapri (r = -0.49) (Table 5; Fig 3-4).

Table 1: Showing frequency of prevalence of Sickle cell anemia and G6PD deficiency among population in village Jamgaon R (Patan) of Durg district of Chhattisgarh, India.

S.No.	Age Group (in years)	Total no. of subjects	Total sickled individuals	Total no. of sickled individuals with G6PD deficiency	HbAS	HbSS
1.	10-20 years	150	05	01	05	01
2.	20-30 years	122	04	--	03	01
3.	30-40 years	37	05	02	04	--
Total		309	14	03	12	02
Total Percentage			4.53%	21.4%	3.88%	0.64%

Table 2: Showing frequency of prevalence of Sickle cell anemia and G6PD deficiency among population in village Khapri of Durg district of Chhattisgarh, India.

S.No.	Age Group (in years)	Total no. of subjects	Total sickled individuals	Total no. of sickled individuals with G6PD deficiency	HbAS	HbSS
1.	10-20 years	104	04	01	04	--
2.	20-30 years	73	03	01	03	--
3.	30-40 years	33	04	--	04	--
Total		210	11	02	11	00
Total Percentage			5.23%	18.18%	5.23%	0.00%

Table 3: Showing frequency of prevalence of Sickle cell anemia and G6PD deficiency among population in village Belaudi of Durg district of Chhattisgarh, India.

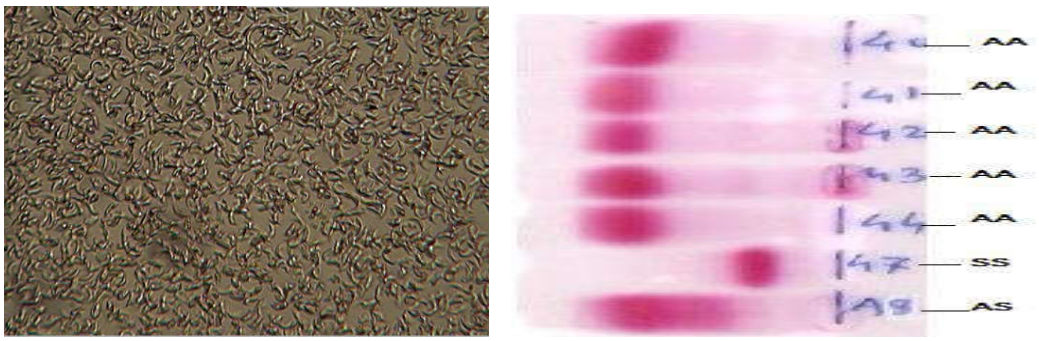
S.No.	Age Group (in years)	Total no. of subjects	Total sickled individuals	Total no. of sickled individuals with G6PD deficiency	HbAS	HbSS
1.	10-20 years	133	06	02	05	01
2.	20-30 years	69	05	01	05	--
3.	30-40 years	64	05	01	05	--
Total		266	16	04	15	01
Total Percentage			6.01%	25.0%	5.63%	0.37%

Table 4: Showing frequency of prevalence of Sickle cell anemia and G6PD deficiency among population in village Thanod of Durg district of Chhattisgarh, India.

S.No.	Age Group (in years)	Total no. of subjects	Total sickled individuals	Total no. of sickled individuals with G6PD deficiency	HbAS	HbSS
1.	10-20 years	161	06	02	04	02
2.	20-30 years	102	05	01	04	01
3.	30-40 years	43	04	01	04	--
Total		306	15	04	12	03
Total %			4.90%	26.6%	3.92%	0.98%

Table 5: Showing Karl Pearson's correlation coefficient among G6PD deficient, HbAS and HbSS individuals.

S.No.	Villages	Correlation coefficient (r) G6PDd and HbS
1.	Jamgaon R (Patan)	0.86
2.	Khapri	-0.49
3.	Belaudi	0.94
4.	Thanod	0.94



a. **b.**

Fig 1: (a) Microscopic view of sickled RBC; (b) Cellulose Acetate Paper Electrophoresis for detection of HbAS and HbSS condition.

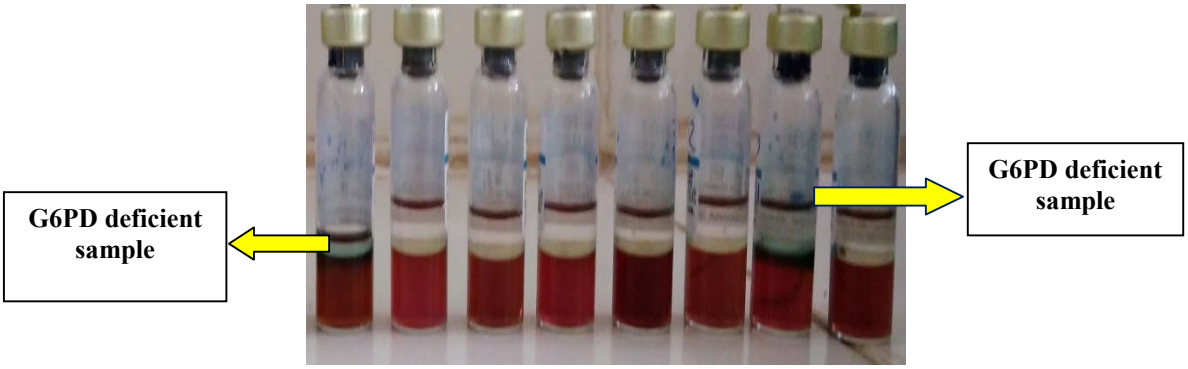


Fig 2: G6PD deficiency test; Partial/No Decolorisation – G6PD deficient sample, Complete Decolorisation – G6PD present.

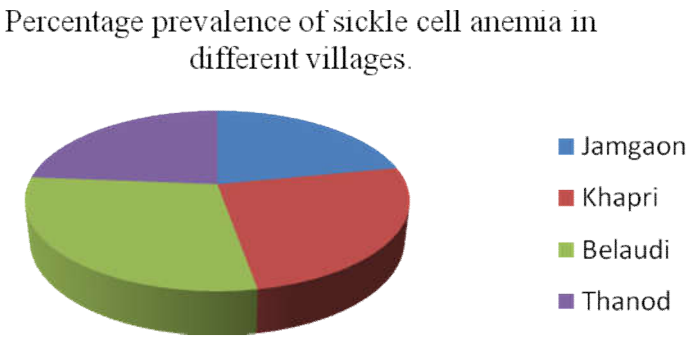


Fig 3: Percentage frequency of sickle cell anemia in different villages of Durg district of Chhattisgarh India.

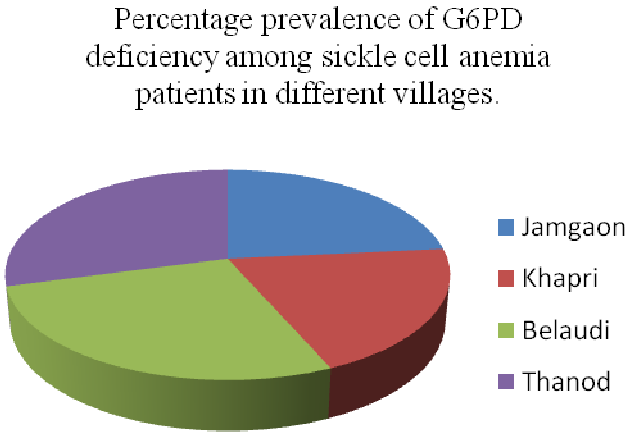


Fig 4: Percentage frequency of G6PD deficiency in different villages of Durg district of Chhattisgarh India.

DISCUSSION

With time genetic diseases are gaining proportionately greater importance as compared to any kind of infectious diseases like beta thalassaemia, sickle cell disease, and haemoglobin E disease which is responsible for significantly high rate of morbidity and mortality in India and other parts of world. The most prevalent inherited blood disorder is sickle cell anemia which results from single point mutation within beta globin gene [13]. Gene flow from the region with high allelic frequency of sickle cell anemia i.e. Sub-saharan Africa, Middle east and India to Europe and various regions of America is due to the movement of population, which leads to increase in sickled individuals throughout the world [14]. As according to different reports available each year approximately 3,00,000 newborns are with sickle cell anaemia and most of these births takes place in countries with poor social and economic condition [6,15]. The tribal communities of South India were first in India among whom the sickle cell mutation

was described [8], but the prevalence among both tribal and non-tribal population is very high. The prevalence rate of sickle cell anemia in India is extremely high in the central and western regions [16]. According to the survey report of ICMR 20% of children with sickle disease died by the age of two and 30 percent of children with sickle cell disease among the tribal community also die before they reach adulthood [17]. The actual incidence and most of our understanding and knowledge of the natural history of the sickle cell disease comes from developed countries where effective interventions have resulted in significant reduction in mortality.

The major clinical manifestation of homozygous sickle cell anemia in India as well as in other countries is vaso-occlusion [18] the incidence of which is high during winter season [19]. Though present study provides valuable information about sickle patients in different villages of Durg district of Chhattisgarh, India and percentage prevalence was reported 4.53%, 5.23%, 6.01% and 4.90% from Jamgaon R (Patan), Khapri, Belaudi and Thanod of Durg district respectively but there is further need for collaborative studies to get a complete picture of SCD in the country. A high prevalence of HbS from Gujarat was also reported i.e. 13-31%. 20.8% prevalence of sickle cell trait among males of Jos, Nigeria was also reported by Egesie *et al*., 2008 [20]. Frempong *et al*., 2008 [21] have also reported 20-40% prevalence of sickle cell trait among Ghanaian population while a similar work done by Baffour *et al*., 2015 in Ghana reported comparatively lower percentage of SCT i.e. 11.3% [22].

Main source of energy for red cell is glucose and there are two major pathways for metabolism of glucose i.e. glycolytic pathway and hexose monophosphate (HMP) shunt or pentose phosphate pathway. Glucose-6-phosphate-dehydrogenase (G6PD) is an enzyme that catalyzes first step of HMP shunt and produces NADPH which is essential for maintenance of reduced glutathione (GSH). GSH plays important role in protecting red cells from oxidative stress and ultimately damage due to oxidative stress [23] and deficiency of this enzyme makes red blood cell sensitive to any kind of oxidative stress. The major clinical manifestations of this disorder are drug induced haemolytic anaemia, neonatal jaundice and chronic non-spherocytic haemolytic anaemia [24]. The overall prevalence of G6PD deficiency is 7.7% of which more than 10% of G6PD deficiency was reported from Chhattisgarh region, West Bengal, Gujarat etc. while less than 5% G6PD deficiency was reported from Tripura, Uttarakhand, Himachal Pradesh, Andhra Pradesh etc. According to survey report of World Health Organization, 0-10% prevalence of G6PD deficiency was reported in India with maximum frequency among tribals as compared to caste population [25, 26]. Moinuddin *et al*., 2017 reported 0.40% prevalence of G6PD deficiency in Bangalore, Karnataka among neonates, they also reported significant difference in prevalence between male and female individuals with p value of 0.002 [27].

The area wise frequency of G6PD deficiency ranges between 0% - 30.70% in Eastern India, 0% - 27.9% in Western India, 0% - 23.21% in Northern India, 0% - 18% in Southern India, 1.86% - 15.71% in North-eastern India and 0% - 19.23% in Central India [28]. Present study was carried out to determine the frequency of G6PD deficiency among population of different villages of Durg district of Chhattisgarh, India. Results reported that percentage frequency of G6PD deficiency are 21.4%, 18.18%, 25.0% and 26.6% from Jamgaon R (Patan), Khapri, Belaudi and Thanod villages from Durg district of Chhattisgarh state respectively.

Sickle cell anemia and Glucose-6-phosphate dehydrogenase deficiency are major genetic problems in Central part of India. There is a concept that a positive association exist between sickled and G6PD deficient individuals and present study was undertaken to determine association between both genetic diseases with an expectation that outcome of the study will be helpful for better quality of life of the people suffering from such diseases. Bouanga *et al*., 1998 reported frequencies of three different alleles of G6PD i.e. B, A+ and A- alleles were 56.9, 20.8 and, 22.2% in the patients as compared to 56.3, 21.2 and, 22.5% in the controls respectively [29]. They concluded that prevalence of G6PD genotypes in HbSS did not differ ($p > 0.05$) from that found in the controls. Mohammad *et al*., 1998 [30] reported 47% G6PD deficiency from HbSS genotype and 19% from control group and on the basis of their data obtained they concluded positive association between G6PD deficiency and sickle cell anemia which is due to endemicity of *falciparum* malaria in regions of Saudi peninsula. Dominique *et al*., 2018 [31] reported the frequency of G6PD A- mutation among 13% of sickled individuals in Senegal which is similar to prevalence in African region and the deficiency of G6PD enzyme is not responsible for severity of disease. Memon *et al*., 2017 [32] also reported that 5.3% of sickled individuals are G6PD deficient but concluded no positive association between both.

However the findings of the present study is contradictory to those of Dominique *et al*, 2018, Memon *et al*., 2017 and Bouanga *et al*., 1998 [29, 31, 32] in that the sickle cell gene leads to elevated G6PD levels in G6PD deficient males. Present result indicates positive as well as negative correlation among both condition with r values of 0.86, -0.49, 0.94, 0.94 from Jamgaon R, Khapri, Belaudi and Thanod of Durg

district respectively which is novelty of our study because no literatures are available regarding positive correlation among sickle cell anemia and G6PD deficiency. Thus present study suggests that sickle haemoglobin do not exert any beneficial effect on G6PD deficiency.

CONCLUSION

On the basis of our study we reached on conclusion that in villages of Chhattisgarh state of India, there is a positive correlation between two monogenetic diseases i.e. Sickle cell anemia and Glucose-6-phosphate dehydrogenase deficiency inspite of several reports of negative correlation from several parts of the world, so based on this study we recommend screening of all sickled population for G6PD study also to protect them from various drug induced hemolysis.

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COMPETING INTERESTS

The authors have declared that no competing interest exists.

REFERENCES

1. Steinberg, M.H. & Dreiling, B.J. (1974). Glucose-6-phosphate dehydrogenase deficiency in sickle cell anemia. A study in adults. Ann. Intl. Med.,80:217-220.
2. Kate, S.L. & Lingojwar, D.P. (2002). Epidemiology of sickle cell disorder in state of Maharashtra. Int. J. Hum. Genet.,2(3):161-167.
3. Rao, V.R. (1988). Genetics and epidemiology of sickle cell anemia in India. Ind. J. Med. Sci.,42:218–22.
4. Modell, B. & Darlison, M. (2008). Global epidemiology of haemoglobin disorders and derived service indicators. Bull. World Health Organ.,86:480–7.
5. Platt, O.S., Thorington, B.D., Brambilla, D.J., Milner, P.F., Rosse, W.F. & Vichinsky, E. (1991). Pain in sickle cell disease. Rates and risk factors. N. Engl J. Med.,325:11–6.
6. Scheinman, J.I. (2009). Sickle cell disease and the kidney. Nat. Clin. Pract. Nephrol.,5:78–88.
7. Gupta, R.B. (2006). Sickle cell disease load in Madhya Pradesh. RMRCT Update. Newslett Regional Med Res Centre Tribals Jabalpur.,3:1–6.
8. Jain, D.L., Sarathi, V., Upadhye, D., Gulhane, R., Nadkarni, A.H. & Ghosh, K. (2012). Newborn screening shows a high incidence of sickle cell anemia in Central India. Hemoglobin.,36:316–22.
9. Putul, A. (2017). Sickle cell: A silent killer in Chhattisgarh state.
10. Kumar, P., Yadav, U. & Rai, V. (2016). Prevalence of glucose-6-phosphate dehydrogenase deficiency in India: An updated meta-analysis. The Egypt. J. of Med. Hum. Genet.,17:295–302.
11. Mukherjee, M.B., Colah, R.B., Martin, S. & Ghosh, K. (2015). Glucose-6-phosphate dehydrogenase (G6PD) deficiency among tribal populations of India - Country scenario. Ind. J. Med. Res.,141:516-520.
12. Sarkar, S., Biswas, N.K., Dey, B., Mukhopadhyay, D. & Majumder, P.P. (2010). A large, systematic molecular genetic study of G6PD in Indian populations identifies a new non-synonymous variant and supports recent positive selection. Infect. Genet. Evol.,10:1228-36.
13. Saraswathy, K.N. & Sachdeva, M.P. (2008). G6PD Deficiency, Sickle Cell Trait, Haptoglobin and Transferrin Polymorphisms among Koyadoras and Nayakpods of Andhra Pradesh. Anthropologist.,10:163-165.
14. Piel, F.B., Patil, A.P., Howes, R.E., Nyangiri, O.A., Gething, P.W. & Dewi, M. (2013). Global epidemiology of sickle haemoglobin in neonates: a contemporary geostatistical model-based map and population estimates. Lancet.,381:142–51.
15. Mittal, H., Roberts, L., Fuller, G.W., O'Driscoll, S., Dick, M.C. & Height, S.E. (2009). The effects of air quality on haematological and clinical parameters in children with sickle cell anaemia. Ann. Hematol.,88:529–33.
16. Bhukhanvala, D.S., Sorathiya, S.M., Shah, A.P., Patel, A.G. & Gupte, S.C. (2012). Prevalence and hematological profile of beta-thalassemia and sickle cell anemia in four communities of Surat city. Ind. J. Hum. Genet.,18:167–71.
17. Rupani, M.P., Vasava, B.C., Mallick, K.H., Gharat V.V. & Bansal, R. (2012). Reaching community through school going children for sickle cell disease in Zankhvav village of Surat district, Western India. Online. J. Health. Allied. Sci.,11:4.
18. Kaur, M., Das, G.P. & Verma, I.C. (1997). Sickle cell trait & disease among tribal communities in Orissa, Madhya Pradesh & Kerala. Ind. J. Med. Res.,105:111–6.
19. Mohanty, D. & Mukherjee, M.B. (2002). Sickle cell disease in India. Curr. Opin. Hematol.,9:117–22.
20. Egesie, O.J., Joseph, D. E., Isiguzoro, I. & Egesie, U. G. (2008). Glucose-6-phosphate dehydrogenase (G6PD) activity and deficiency in a population of Nigerian males resident in Jos. Nigerian J. of Physiol. Sci.,2008;23(1-2):9–11.
21. Ohene-Frempong, K., Oduro, J., Tetteh, H. & Nkrumah, F. (2008). Screening newborns for sickle cell disease in Ghana. Pediatrics.,121(2):120–121.

22. Antwi-Baffour, S., Asare, R.O., Adjei, J.K., Kyeremeh, R. & Adjei, D.N. (2015). Prevalence of hemoglobin S trait among blood donors: a cross-sectional study. *BMC Research Notes*.,8:583.
23. Ruwende, C. & Hill, A. (1998). Glucose-6-phosphate dehydrogenase deficiency and malaria. *J. of Mol. Medicine*.,76(8):581–588.
24. Mehta, A., Mason, P.J. & Vulliamy, T..J. (2000). Glucose-6-phosphate dehydrogenase deficiency: Review article. Baillieres Best Pract. Res. Clin. Haematol.,13(1):21-38.
25. Nimgaonkar, V., Krishnamurti, L., Prabhakar, H. & Menon, N. (2014). Comprehensive integrated care for patients with sickle cell disease in a remote aboriginal tribal population in southern India. Pediatr. Blood. Cancer.,61:702–5.
26. Daigavane, M.M., Jena, R.K. & Kar, T.J. (2013). Perinatal outcome in sickle cell anemia: A prospective study from India. Hemoglobin.,37:507–15.
27. Moinuddin, M.K., Gagandeep, V. & Mutalik, S. (2017). Prevalence of glucose 6 phosphate dehydrogenase (G6PD) deficiency in a community by newborn screening. Int. J. of Contemp. Pediatr.,4(3):1018-1020
28. Shah, I.I., Jarullah, J. & Jarullah, B. (2018). Prevalence of Glucose-6-Phosphate Dehydrogenase (G6PD) Deficiency in India: A Systematic Review. Adv. in Biosci. and Biotech.,9:481-496.
29. Bouanga, J.C., Mouele, R. & Prehu, C. (1998). Glucose-6-phosphate dehydrogenase deficiency and homozygous sickle cell disease in Congo. Hum. Hered.,48:192-197.
30. Mohammad, A.M., Kasim, O.A. & Bajakian, K.M. (1998). Sickle cell disease in Bahrain: Co-existence and interaction with glucose-6-phosphate dehydrogenase (G6PD) deficiency.,J Trop Pediatr. 1998;44:70-2.
31. Dominique, D., Ousseynou, B., & Ndiaye, M. (2018). Prevalence of glucose-6-phosphate dehydrogenase deficiency (A-376/202) in homozygous sickle cell patients in Senegal and its clinical impact. Afr. J. Biochem. Res.,12(6):55-62.
32. Memon, M.J., Gahine, R. & Hussain, N. (2017). Influence of glucose-6-phosphate dehydrogenase deficiency upon clinic-haematological and biochemical expression of patients with sickle cell disease. Int. J. Adv. Med.,4(2):573-580.