J Life Science, 3(1): 47-49 (2011)
PRINT: ISSN 0975-1270 ONLINE: ISSN 2456-6306 DOI: 10.31901/24566306.2011/03.01.07

# Prevalence of G6PD Deficiency and Abnormal Hemoglobin in Mental Retardation from North Coastal Andhra Pradesh

**S. Krishnasubha, V. Lakshmikalpana, M. Ramesh, G. Sudhakar and T.L Pathi**

*Department of Human Genetics, Andhra University, Visakhapatnam 530 003, Andhra Pradesh, India*

**KEYWORDS** G6PD Deficiency. Abnormal Hemoglobins. Association. Mental Retardation. North Coastal Andhra Pradesh

**ABSTRACT** The results are presented on G6PD deficiency and abnormal hemoglobins in mentally retarded school children of Visakhapatnam city of Andhra Pradesh in South India. Comparatively increased incidence of G6PD deficiency was found in mentally retarded individuals (4%). Abnormal hemoglobins were also observed in mentally retarded patients (4%). The results were compared with the data from control samples.

## INTRODUCTION

Mental retardation is a genetic disorder manifested in significantly below average overall intellectual functioning and deficits in adaptive behavior. Mental retardation is a particular state of functioning that begins in childhood and is characterized by decreased intelligence and adaptive skills and also is the most common developmental disorder (Bregman 1991). Mental retardation in young children is often missed by clinicians. The condition is present in 2 to 3 percent of the population, either as an isolated finding or as part of a syndrome or broader disorder (Daily et al. 2000). McLaren and Bryson (1987) report that the prevalence of mental retardation appears to increase with age up to about the age of 20, with significantly more males than females identified. Mental retardation is a common and distressing disorder whose origins are poorly understood. A state of mental retardation may be produced by various endogenous and exogenous influences acting independently or in concern with each other. In at least 30 to 50 percent of cases, physicians are unable to determine etiology despite thorough evaluation (Baird and Sadovnick 1985). A number of single-gene disorders result in mental retardation. Many of these are associated with atypical or dysmorphic physical characteristics (Sultana et al. 1995). Metabolic disorders are another possible cause of mental retardation. In some cases (e.g., PKU, hypothyroidism), retardation is preventable with early treatment (Scriver 1995). Approximately 3% of the population has an intelligence quotient (IQ) of less than 70, among whom a cause for the mental retardation can be established in less than half of all cases (Flint et al. 1995). The prevalence of severe mental retardation is about 3 per 1.000 population and 30 per 1.000 for mild mental retardation (Harper 1993).

Baker (1992) represented effect of G-6 PD deficiency on sickle cell disease in Saudi Arabia. Steen et al. (1999) and Schatz and McClellan (2006) studied sickle cell disease as a neuro-developmental disorder, the trait increasing the risk of mild mental deficiency. Seth et al. (1981) observed a high frequency of G6PD deficiency (11.8%) in mentally retarded individuals.

Saleh (2009) reported two cases of G6PD deficiency with autism.

The present study was conducted to seek association, if any, of genetic markers glucose-6-phosphate dehydrogenase deficiency and abnormal hemoglobins with mental retardation in school children of Vishakapatnam city of North Coastal Andhra Pradesh.

## METHODOLOGY

The material for the present study was collected, March 2008 to March 2009 from Lebenshilfe School, Vishakhapatnam city in Andhra Pradesh, India. A total of 100 intravenous blood samples were collected from mentally retarded individuals and analysed for G6PD deficiency and abnormal hemoglobins. Normal healthy individuals (n=100) were taken as age

*Address for correspondence:*
S. Krishnasubha
Department of Human Genetics
Andhra University, Vishakapatnam 530 003,
Andhra Pradesh, India
*Mobile:* 09177282561
*E-mail:* krishnasubhareddy@yahoo.com

and sex matched controls. G6PD deficiency was determined by standard quantitative (kits obtained from Crest Biosystems, Goa, India) and qualitative (Bhattacharya et al. 1990) methods and abnormal hemoglobins were typed using standard cellulose acetate membrane electrophoresis (Kate et al. 1976). The statistical analysis of the phenotype data comprises calculation of allele frequencies by direct gene counting method and a Chi-square test on Hardy-Weinberg equilibrium.

## RESULTS

Table 1 represents the phenotype and allele frequencies of Glucose-6-Phosphate Dehydrogenase among patients and control groups. The table shows that G6PD deficiency was observed in both the groups 4% in cases and 3% in control group. Considering allele frequencies, the frequency of *GD B* $^{-}$allele was higher in patient group (0.0420) compared with control group (0.0330). The Chi-square test for homogeneity was found to be statistically non-significant (Chi-square: 0.1478; d.f. =1; 0.80>p>0.70).

**Table 1: Phenotypes and gene frequencies of G6PD among patient and control groups**

| *Phenotypes / Alleles* | *Patient group* | | *Control group* | |
|---|---|---|---|---|
| | *Number* | *Percent* | *Number* | *Percent* |
| *Phenotype* | | | | |
| Normal | 96 | 96.00 | 97 | 97.00 |
| Deficient | 4 | 4.00 | 3 | 3.00 |
| Total | 100 | 100.00 | 100 | 100.00 |
| *Allele* | | | | |
| G6PD* B+ | 0.9580 | | 0.9670 | |
| G6PD* B- | 0.0420 | | 0.0330 | |
| Total | 1.0000 | | 1.0000 | |

Table 2 provides glucose-6-phosphate dehydrogenase enzyme assays among study and control groups. It is observed from the table that G6PD enzyme levels range between 6.4 and 18.7. Below the normal value two cases of males (3.44%) and two cases of females (4.76%) were observed in patient group, whereas in control group one case of male (2%) and two cases of females (4%) were observed.

Table 3 shows phenotypes and allele frequencies of hemoglobin (HB) system among patient and control groups. This table shows that HB AS shows low incidence among patient group (4%) whereas in control group this phenotype is completely absent. Rare phenotype HB SS was completely absent in both the groups. Considering allele frequencies, the *HB*S* allele frequency was 0.0200 in patient group and the allele was completely absent in control group. The homogeneity Chi-square test for this blood protein system showed statistically non significant result in patient group ($\chi^2$: 1.7076; d.f.=1; 0.20>P>0.10).

**Table 2: G6PD enzyme assays among patient and control groups**

| *Gender* | *G6PD value / range* | *Patient group* | | *Control group* | |
|---|---|---|---|---|---|
| | | *Number* | *Percent* | *Number* | *Percent* |
| Male | 6.4 -18.7 | 56 | 96.56 | 49 | 98.00 |
| | <6.4 | 2 | 3.44 | 1 | 2.00 |
| | Total | 58 | 100.00 | 50 | 100.00 |
| Female | 6.4 – 18.7 | 40 | 95.24 | 48 | 96.00 |
| | < 6.4 | 2 | 4.76 | 2 | 4.00 |
| | Total | 42 | 100.00 | 50 | 100.00 |

**Table 3: Phenotypes and allele frequencies of hemoglobins among patient and control groups**

| *Phenotypes / Alleles* | *Patient group* | | *Control group* | |
|---|---|---|---|---|
| | *Number* | *Percent* | *Number* | *Percent* |
| *Phenotype* | | | | |
| HB AA | 96 | 96.00 | 100 | 100.00 |
| HB AS | 4 | 4.00 | - | - |
| HB SS | - | - | - | - |
| Total | 100 | 100.00 | 100 | 100.00 |
| *Allele* | | | | |
| *HB *A* | 0.9800 | | 1.0000 | |
| *HB *S* | 0.0200 | | 0.0000 | |
| Total | 1.0000 | | 1.0000 | |

## DISCUSSION

In the present study, a slightly increased incidence of G6PD deficiency has been found in mentally retarded individuals compared with matched population of normal intelligence. In mental retardation, 4% individuals were found to be deficient in glucose-6-phosphate dehydrogenase compared with 3% of the controls, the two values being almost similar. Also, comparatively higher number of mental retardation individuals was found to exhibit sickle cell trait and G6PD deficiency. It is, therefore, presumed that selection probably operates against these two genetic systems simultaneously in malarial regions. Kernicterus is a major cause of death during the neonatal period of mental retardation and cerebral palsy with high tone deafness. It may occur due to the deficiency of G6PD

enzyme which is prone to develop acute hemolysis when exposed to hemolytic triggers such as antihistamines, anti-malarial drugs, antibiotics, analgesics and antipyretics, herbal medicines and miscellaneous agents and drugs. Babies with G6PD deficiency who are exposed to hemolytic triggers may be controlled to some extent by educating parents and health professionals to protect children from various triggering mechanisms and the incidence of kernicterus may be reduced. To achieve this all children with G6PD deficiency should be identified. Early detection of G6PD deficiency with appropriate management can prevent mental handicap and related developmental disabilities. In our study HB AS were observed in 4 cases of mentally retarded individuals. No sickle cell disease subject was found in either patient or control groups. Regarding abnormal hemoglobins Steen et al. (1999) and Schatz and Mcclellan (2006) observed subtle brain abnormalities in children with sickle cell disease, stating that this condition was mainly associated with a 23-fold increase in the risk of mild mental deficiency.

## ACKNOWLEGMENTS

The authors gratefully acknowledge the help and co-operation received from the subjects and administrative members of the Lebenshilf School, Vishakhapatnam while conducting the present study.

## NOTE

Based on the intelligence quotient (IQ), mental retardation is classified into four types: Mild mental retardation (IQ scores between 50 and 70), Moderate mental retardation (IQ scores between 40 and 54), Severe mental retardation (IQ scores between 25 and 39) and Profound mental retardation (IQ scores < 25).

## REFERENCES

Baker HA 1992. Effect of G-6 PD deficiency on sickle cell disease in Saudi Arabia. *Indian Journal of Pediatrics*, 59: 3.

Baird PA, Sadovnick AD1985. Mental retardation in over half-a-million conservative livebirths: An epidemiologicalstudy. *American Journal of Mental Deficiency*, 89: 323-330.

Bhattacharya T, Swarup Mitra S, Sumanth Kumar G 1990. Agarose gel electrophoresis of G6PD a new, quick and cheaper method and with starch gel technique. *Indian Journal of Human Genetics*, 16: 37 – 42.

Bregman JD 1991. Current developments in the understanding of mental retardation. Part II: Psychopathology. *Journal of the American Academy of Child and Adolescent Psychiatry*, 30: 861-872.

Daily DK, Ardinger HH , Holmes GE 2000. Identification and evaluation of mental retardation. *American Family Physician*, 61(4): 1059-1067.

Flint J, Wilkie AOM, Buckle VJ, Winter RM, Holland AJ, McDermid HE 1995. The detection of sub telomeric chromosomal rearrangements in idiopathic mental retardation. *Nature Genet*, 9: 132-140.

Harper PS 1993. *Practical Genetic Counselling.* 4th Edition. Butterwoth Heinemann.

Kate SL, Khedkar AV, Mukherjee BN 1976. Cellulose acetatemembrane electrophoresis, simple, rapid and inexpensive method for detection of hemoglobin variants. *Indian Journal of Human Genetics*, 2: 123 -124.

McLaren J, Bryson SE 1987. Review of recent epidemiological studies in mental retardation: Prevalence, associated disorders, and etiology. *American Journal of Mental Retardation*, 92(3): 243-254.

Saleh M ,Salehi AL, Mohammad Ghaziuddin 2009. G6PD deficiency in autism a case series from Saudi Arabia. *European Child & Adolescent Psychiatry*, 18(4): 227 – 230.

Schatz J, Mcclellan CB 2006. Sickle cell disease as a neurodevelopmental disorder. *Ment Retard Dev Disabil Res Rev*, 12(3): 200.

Scriver CR 1995. *The metabolic and molecular bases of inherited disease.* 7th Edition. New York: McGraw-Hill.

Seth PK, Tara Devi S, Seth S 1981. Glucose-6-phosphate dehydrozenase deficiency and mental retardation. *J Inher Metab Dis*, 4: 93-94.

Steen Grant, Xioping R, Raymond Xiong, Mulhern K, James W, Winfred Langston, Wang C 1999. Subtle brain abnormalities in children with sickle cell disease: Relationship to blood hematocrit. *Ann Neurol*, 45: 279-286.

Sultana SAG, LamPoTang TRL, Wright F, Linderman R, PurvisSmith S 1995. Fragile X mental retardation in an Indonesian family. *Medical Journal of Indonesia*, 4: 17-17.