

## Heritability of Some Important Parameters of the Antioxidant Defense System Like Glucose-6-Phosphate Dehydrogenase, Catalase, Glutathione Peroxidase and Lipid Peroxidation in Red Blood Cells by Twin Study

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**KEY WORDS** Heritability; red blood cell; enzymes; twin study.

**ABSTRACT** Data on the important parameters of antioxidant defense system like glucose-6-phosphate dehydrogenase (G6PD), catalase, glutathione peroxidase (GSH-PX) and lipid peroxidation (lpx) from 7 pairs of monozygotic (MZ) and 7 pairs of dizygotic (DZ) like-sexed male twin pairs were subjected to variance analysis to examine genetic significance of those biochemical traits. The results of variance analysis and F test show the involvement of significant component of genetic variability in case of G6PD and catalase. The estimates of heritability based on variances of MZ and DZ twins are 0.93 (G6PD), 0.72 (catalase), 0.60 (GSH-PX) and 0.50 (lipid peroxidation).

### INTRODUCTION

The examination of role of heredity and environment and their interactions in the variation of biochemical traits specially enzymes involved in physiological and metabolic activities are comparatively less studied than morphometric traits in man.

Considerable evidence indicates that the maintenance of protein redox status is of fundamental importance for cell function. Protein oxidation is related to the components of antioxidant defense system (Altomare et al. 1997). It has been established that environmental toxicant induced intracellular oxidative stress countered by changes in the components of antioxidant defense system (Mukhopadhyay et al. 1988; Kumagai et al. 1997). Glucose-6-Phosphate Dehydrogenase (G6PD), catalase, glutathione peroxidase (GSH-PX) and lipid peroxidation (lpx) are a few of the enzymes associated with the maintenance of glutathione status (Chidambaram and Baradarajan 1996). The levels of these enzymes are often used both in vivo and in vitro studies on the effects of anti-

oxidants (Mukhopadhyay et al. 1988; Look et al. 1997; Bagchi et al. 1997).

Given above, to assess the influence of genetic and environmental components on some important parameters of the antioxidant defense systems, we studied the levels of G6PD, catalase, GSH-PX and lipid peroxidation in the red blood cells using twin method of study.

### MATERIALS AND METHODS

Seven pairs of monozygotic (MZ) male and 7 pairs of dizygotic (DZ) like-sexed male twin pairs were obtained from whom the required blood samples were collected. They denied taking any medication for two weeks prior to blood collection. The zygosity of twins, from whom the blood samples were collected, was determined with special emphasis mainly on serogenetic tests like ABO, Rh, MN, haptoglobin and PTC along with similarity method of diagnosis (Siemens 1924).

G6PD was estimated according to the method described by McKenna et al. (1983). The assay was carried out monitoring the change in absorbance of NADP (Sigma). Catalase was estimated according to Beers and Sizer (1952) by measuring the decrease in the absorbance of  $H_2O_2$  at 240 nm. Glutathione peroxidase was determined according to Levander et al. (1988) by measuring the decrease in absorbance of NADPH (Sigma) at 340 nm. Lipid peroxidation was estimated by measuring malondialdehyde formation as described by Takayama (1980).

### RESULTS AND DISCUSSION

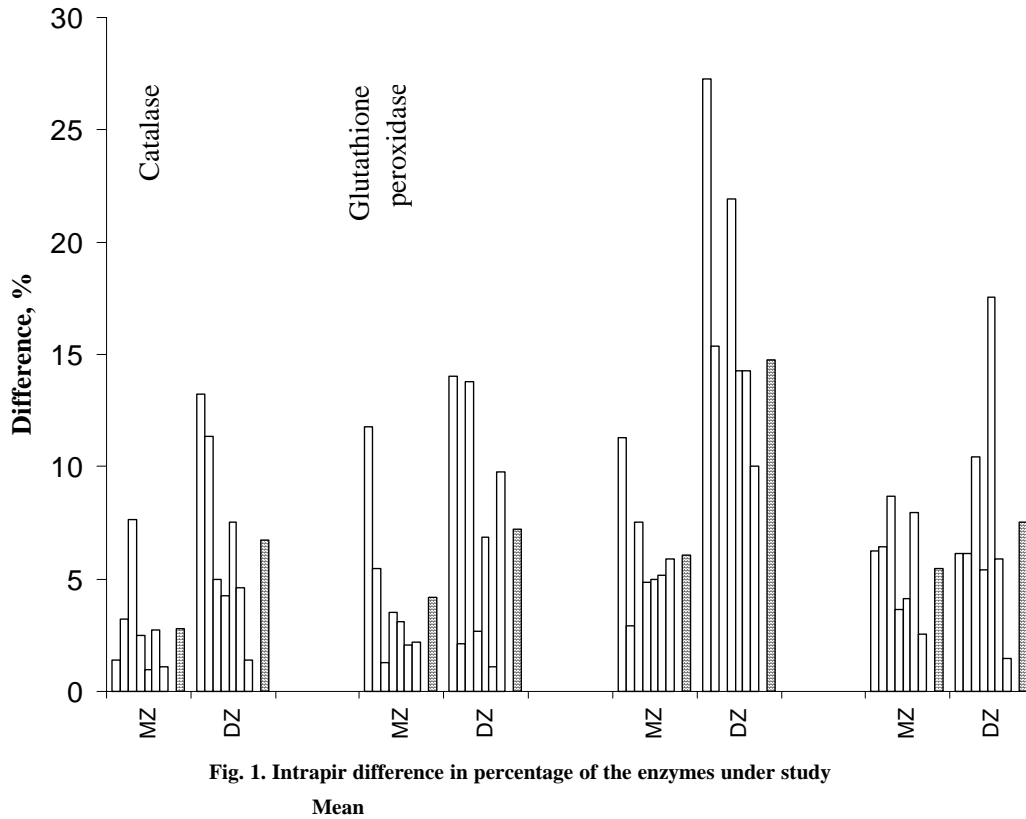
The intrapair difference in percentage levels

of glucose-6-phosphate dehydrogenase (G6PD), catalase, glutathione peroxidase (GSH-PX) and lipid peroxidation (Ipx) in MZ and DZ twins computed on the basis of enzyme levels given

in table 1 were utilized to construct figure 1. It will be seen that MZ twins show less difference with respect to all enzymes compared to those DZ twins. The mean intrapair difference in the

**Table 1: Intrapair difference in percentage levels of enzymes in monozygotic and dizygotic male twin pairs under study**

Pair Number	Catalase (values in imoles of H <sub>2</sub> O <sub>2</sub> decomposed / min / mg protein)		Glutathione Peroxidase (values in imoles NADPH oxidised / min / mg protein)		Glucose-6-Phosphate Dehydrogenase (values in imoles NADPH formed / min / mg protein)		Lipid Peroxidation (values in imoles of MDA formed / mg protein)	
	MZ	DZ	MZ	DZ	MZ	DZ	MZ	DZ
1	1.42	13.24	11.76	14.03	11.30	27.27	6.28	6.13
2	3.19	11.35	5.45	2.12	2.94	15.38	6.45	10.42
3	7.65	4.98	1.27	13.80	7.56	0	8.69	10.42
4	2.47	4.25	3.52	2.70	4.85	21.95	3.66	5.39
5	1.0	7.53	3.10	6.85	5.00	14.28	4.12	17.51
6	2.76	4.59	2.04	1.12	5.17	14.28	7.97	5.88
7	1.09	1.42	2.16	9.80	5.88	10.00	2.53	1.43
Mean	2.79	6.76	4.18	7.20	6.1	14.74	5.46	7.56



**Fig. 1. Intrapair difference in percentage of the enzymes under study**

Mean

**Table 2: Mean variances of G6PD, catalase, glutathione peroxidase and lipid peroxidation in red blood cells**

Types of antioxidants and zygosity	No. of twin pairs	Variance	F-ratio
<i>G6PD</i>			
MZ	7	2.71 x 10 <sup>-5</sup>	13.50*
DZ	7	3.66 x 10 <sup>-4</sup>	
<i>Catalase</i>			
MZ	7	1.27	3.63**
DZ	7	4.61	
<i>Glutathione peroxidase</i>			
MZ	7	1.24 x 10 <sup>-5</sup>	2.52***
DZ	7	3.13 x 10 <sup>-5</sup>	
<i>Lipid peroxidation</i>			
MZ	7	3.34	2.01***
DZ	7	6.71	

\* P &lt; 0.010

\*\* P &lt; 0.100

\*\*\* P &lt; 0.250

percentage levels of G6PD, catalase, GSH-PX and lpx are always less in MZ twins than their counterparts in DZ twins. This simply indicates the genetic basis of the enzymes concerned. The mean intrapair variances in G6PD, catalase, GSH-PX and lpx for MZ and DZ twin pairs along with MZ/DZ variances are shown in table 2.

The F-ratios in case of G6PD and catalase are found to be significant at 1% and 10% levels. This is suggestive of significant genetic component of variability in those two enzymes. With some limitations heritability or h<sup>2</sup> statistic (Cavalli-Sforza and Bodmer 1971) has been calculated using formula  $h^2 = (V_{DZ} - V_{MZ}) / V_{DZ}$ . Here h<sup>2</sup> is the proportion of variability in DZ twins attributable to genetic variation and V<sub>DZ</sub> and V<sub>MZ</sub> are intrapair variances of DZ and MZ twin pair respectively. For G6PD, heritability has been found to be 0.93. The estimates of heritability based on variances of MZ and DZ twins were observed for catalase, GSH-PX and lpx to be 0.72, 0.60 and 0.50 respectively. Heritability is found to be least in case of lpx. It is well known that in the vast majority of situations involving lpx proceed through a free radical mediated chain reaction initiated by the abstraction of a hydrogen atom from the unsaturated lipid by a reactive free radical followed by a complex series of propagative reaction. So lpx is the end product estimated whenever unsaturated lipid material undergoes reaction with molecular oxygen to yield lipid hydroperoxides. So it is expected that

influence of environmental factors will play a very important and major role in lpx. Our results are in agreement with this idea.

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