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INTERACTION OF GLUCOSE-6-PHOSPHATE DEHYDROGENASE (G6PD) ENZYME DEFICIENCY AND HAEMOGLOBIN E (HBE) IN TWO TRIBES CO-EXISTING IN THE MALARIAL ZONE OF ASSAM, INDIA.

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Abstract: The paper intended to examine the interaction of two malaria protective genetic traits in the Karbi and the Dimasa populations co-existing in the malarial zone of the Autonomous hill districts of Assam. The frequency of the G6PD deficiency among the Karbi was 8.54% which is comparatively higher than that in the Dimasa (4.96%).The Chi-square comparison between the two populations with respect to G6PD deficiency shows that there is no significant difference between the Dimasa and the Karbi population (X^2=2.596; p=0.10712). It is pertinent to mention here that three homozygous female Karbi individuals was found G6PD deficient but not a single from the Dimasa population. The genotype frequency of HbE among the Dimasa was 0.483 which is comparatively higher than that of Karbi (0.211). The Chi-square comparison between the two populations concerning to G6PD HbE shows that there is a significant difference between the Dimasa and the Karbi populations (X^2=73.905; p=0.00001). A higher incidence of the HbE gene is observed in the population where lower G6PD deficiency is encountered. A significant difference in the prevalence of two malaria protective traits suggests that endogamous and intermarriage may the genes hold in the population and get augmented over time irrespective of malaria.
Keywords: *G6PD, HbE, Dimasa, Karbi, Assam.*

Introduction

Glucose-6-phosphate dehydrogenase (G6PD) is an enzyme that plays an essential role in cell metabolism. The normal function of G6PD is to neutralize the oxidising substances and protect red blood cells from oxidative stress. So to get rid of such oxidative stress enough amount of G6PD enzyme is required. Otherwise can damage or destroy the red blood cells by oxidative stress leading to a condition called haemolytic anaemia. Allison (1960) and Motulsky (1960) disclosed that G6PD deficiency is known to provide a selective advantage in the presence of malarial parasitemia. The deficiency of the G6PD enzyme is highly polymorphic in the malaria endemic areas. It is an example of balanced polymorphism, in which the high rate of mortality caused by this disorder is offset by the protection that it offers against Plasmodium falciparum malaria (Luzzatto & Bienzle., 1979).

Haemoglobin is the red respiratory protein present in the blood and carries oxygen from blood to organs and tissues. In human beings, a number of physiological haemoglobins occur normally. There are

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various disorders in the synthesis of normal haemoglobin. Such disorders are grouped under the term Haemoglobinopathy. HbE is one of the haemoglobinopathies that onset by the replacement of glutamic acid by lysine at position 26 of the beta globin-chain. There are various supporters of the protective advantages of HbE against tropical Malaria. Kruatrachue et al. (1969) provided a report relevant to the hypothesis that heterozygosity for Haemoglobin E and thalassemia offers some selective advantage in Plasmodium falciparum infection from Thailand. A hospital-based study conducted in Thailand by Hutagalung et al., (1999) suggested that the haemoglobin E trait may ameliorate the course of acute falciparum malaria. Sharma & Mahanta, (2009) observed a positive correlation between HbE gene frequency and malaria incidence of P. falciparum in malaria infection in the malaria endemic zone of Assam. Karbi Anglong (east and west) and Dima Hasao districts of Assam are one of the malaria endemic places of Assam. The Dimasa and the Karbi tribes are the major ethnic populations inhabiting in this place from time immemorial.

About Karbi and Dimasa

The Karbi are one of the major endogenous tribes of Assam (Das, 1997). The main means of livelihood is agriculture. Karbi people presently inhabit in Assam, Meghalaya, and Arunachal Pradesh. Karbis are one of the largest endogamous tribes of Assam. Dimasa, is the second largest tribal population inhabited in the autonomous hill districts of Assam. They are mainly confined in Dima Hasao District formerly called North Cachar Hill District of Assam. They are also one of the major tribal populations inhabited in the autonomous hill districts of Assam. Like Karbi, they also have their own unique culture, religion and more or less endogamous.

Materials and methods

Altogether 508 healthy adult individuals comprising of 246 Karbis (193 males and 53) and 262 Dimasas (148 males and 114 females) by using snow ball sampling technique (Goodman, 1961). Intravenous blood sample was collected from healthy adult individuals of both sexes with the prior consent of the subject was conducted during 2019 to 2022 by organizing camps at different localities of autonomous hill districts namely Karbi Anglong and Dima Hasao. The collected blood samples were brought to the Molecular Anthropology Laboratory of the Department of Anthropology, Cotton University, Guwahati for analyses. Extra care was taken during the collection and labelling of the sample numbers. For screening G6PD deficiency DPIP Dye decolourization method was adopted (Bernstein, 1962). The suspected samples of G6PD deficiency in the screening test were further analyzed for confirmation by adopting the ICMR standard method of quantitation of G6PD enzyme activity. The haemoglobin fraction was separated by cellulose acetate membrane electrophoresis with alkaline buffer. Fetal haemoglobin was estimated following Lewis and Dacie (1991).

Results

Out of 242 Karbi male and female individuals screened for G6PD deficiency, 18 male and 3 female individuals with a frequency of 8.54% are found to be G6PD deficient. However, among the Dimasas13 male individuals are found to be G6PD deficient with a frequency of 4.96% as shown in Table 1. The Chi-square comparison between the two populations with respect to G6PD deficiency shows that there

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is no significant difference between the Dimasa and the Karbi tribes (X^2=2.596; p=0.10712). It is pertinent to mention here that three homozygous female Karbi individuals was found to be G6PD deficient but not a single from the Dimasa population.

Table 1. Distribution of G6PD deficiency in the Dimasa and the Karbi tribes of autonomous hill districts of Assam

Population	Sample size	G6PD				Chi-square (df=1)	*p*-value
		Normal		Deficient			
		No.	Percentage	No.	Percentage		
Dimasa	262	249	95.04	13	4.96	2.596	0.10712
Karbi	246	225	91.46	21	8.54		

*significant at p < 0.05

The distribution of Haemoglobin E among the Karbi and the Dimasa tribes of autonomous hill districts of Assam is shown in Table 2. Among the Karbis, the higher phenotypic frequency is observed in HbAA with 64.23% followed by HbAE 29.27% and HbEE (6.50%). In the case of Dmasas, the higher phenotype frequency is observed in HbAE (47.71%) followed by HbAA in Dimasa is 27.86% and HbEE (24.43%).The Chi-square comparison between the two populations with respect to G6PD HbE shows that there is no significant difference between the Dimasa and the Karbi tribes (X^2=73.905; p=0.00001).

Table 2. Distribution of HbE in the Dimasa and the Karbi tribes of autonomous hill districts of Assam

Population	Sample size	HbAA		HbAE		HbEE		Gene frequency	Chi-square (df=2)	*P*-value
		No.	%	No.	%	No.	%			
Dimasa	262	73	27.86	125	47.71	64	24.43	0.483	73.905	0.00001
Karbi	246	158	64.23	72	29.27	16	6.50	0.211		

*significant at p < 0.05

Discussion

The Dimasa are one of the members of the Kachari group. The Bodo are one of the Kachari members which is the highest HbE gene frequency being recorded with 0.645 (Deka, et al., 1988). Different studies reveal a higher gene frequency of HbE in Kachari groups. A similar trend of higher HbE gene frequency is observed in Northern Kachari groups like Rabha 0.535 (Das et al., 1980), Mech Kachari 0.536 (Balgir 1992), and also among the Sonowal Kachari of Upper Assam 0.509 (Das et al., 1979), Sonowal Kachari of lower Assam 0.549 (Das and Deka 1980). Slightly lowered gene frequency is revealed in the Southern Kachari group with 0.483 in Dimasa, 0.477 in Lalung and 0.499 (Das et al., 1980) in Garos. In the contrary, non-Kachari groups like Karbi, the prevalence of the HbE gene is disagreement in with a lower gene frequency of 0.211.

The positive correlation between malaria and the HbE gene is reported by many studies. Kar et al. (1992) reported HbE gene was found to be twice as common in the high malarial zone hill region (0.1918) than in the plains (0.0959), where there is a low incidence of malaria conforms to the study of Flatz et al., (1964) in Thailand. A positive correlation between HbE and malaria has been found in a

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study conducted in Southeast Asian refugees (Vernes et al., 1986). HbE, one of malaria protective genetic traits described by many scholars was found to be significantly different between the two populations sharing the same eco-zone.

Regarding G6PD deficiency, deferential prevalence is observed among the Kachari groups irrespective of Northern and Southern. It is observed that 3.70% in Lalung (Das and Deka, 1985), 15.80% in Rabha (Das and Deka, 1982), 11.84% in Garo (Das et al., 1980), 2% in Kachari (Flatz et al., 1972) and 4.96% in the Dimasa.

The Karbi tribe shares the same eco-zone with the Dimasa tribe in the autonomous hills districts of Assam revealing higher (8.54%) G6PD deficiency along with three homozygous females. In the same way, the frequency of higher homozygous HbEE is found among the Dimasas (24.43%) than the Karbi (6.50%). This indicates that there will be a chance of getting a higher frequency of G6PD deficiency among the Karbis and HbE in the Dimasas. (Fig.1)

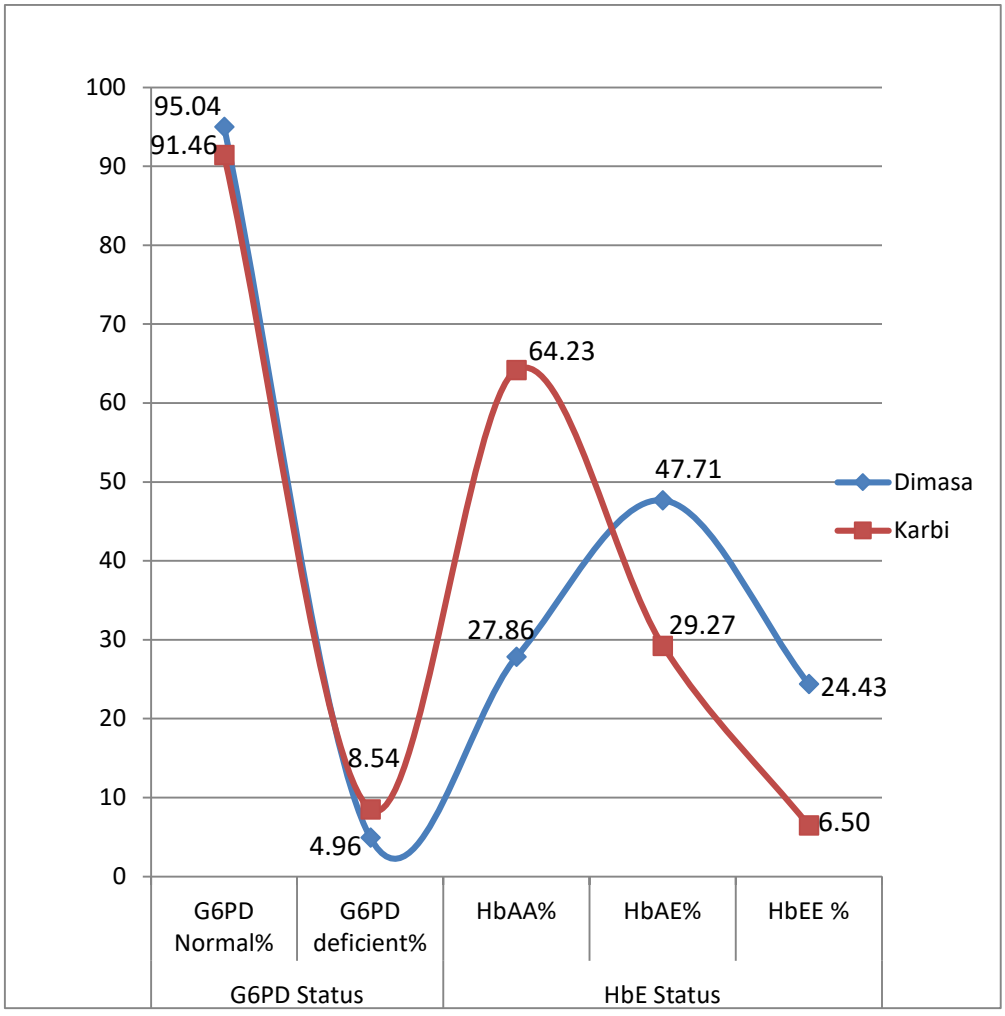

Fig.1 Incidence of G6PD and HbE in the Dimasa and the Karbi tribes of autonomous hill Districts of Assam.

Conclusion

The two studied populations show disagreement in the interaction of two different malaria protective

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genetic traits i.e. G6PD deficiency and Haemoglobin E, even though both the Karbi and Dimasa populations co-existing in the same eco-zone from time immemorial. A higher incidence of the HbE gene is observed in the population where lower G6PD deficiency is encountered. The higher frequency of HbE genes in the Dimasas of the Kachari group and higher incidence of the G6PD deficiency in the Karbi tribe suggested that endogamous and intermarriage may the genes hold in the population and get augmented over time irrespective of malaria. That's why it may be the reason for variation in the prevalence of HbE and G6PD deficiency in the Dimasa and the Karbi tribes residing in the same eco-zone of autonomous hill districts of Assam.

Ethical Clearance

This study was approved by the Institutional Ethics Committee for Human Research, Academic Section of Cotton University, Guwahati (Ref. No. CU/ACA/ETHICS/2018/08). The sample collection was performed during 2018-2022. The aims and objectives of the study were properly explained to all the volunteers and written informed consent was obtained before collection of blood samples from all individuals participants included in the study.

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Conflict of interest

The authors declare no conflict of interest.

Author's Contribution

Maishnam Rustam Singh (MRS) conceived the idea. The data was collected by Karnajit Mangang (KM). MRS and KM analyses the data and prepared the tables. KM drafted the manuscript and MRS edited and finalized the manuscript.

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