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Mortality, Inbreeding, Genetic Load in Rellis: A Subdivided Population of Andhra Pradesh, India

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Summary. **We have studied the effects of inbreeding on fertility and mortality for 89 Chachati Relli and 132 Kapu Relli couples with different hemoglobin genotypes. The frequency of consanguineous marriages is higher in Chachati Relli than in Kapu Relli. The effect of inbreeding is clearly evident in the mortality of offspring of AA x AA and AA x AS matings in Chachati Relli and AA x AA matings in Kapu Relli, possibly due to homozygosity for recessive lethals. However, the mortality rates for AS x AS inbred couples in the two sub populations were less than for non-inbred couples, possibly due to prenatal selection against recessive lethals. The low value of the B/A ratio in Chachati Relli suggests that the genetic load is segregational while the negative B value in Kapu Relli is attributed to reduced mortality in different inbred groups.**

Key words—Inbreeding-Mortality-Genetic Load-Relli.

INTRODUCTION

Studies on inbreeding have considerable significance as they help to identify homozygotes for rare recessive genes. South India in general, and Andhra Pradesh in particular, are known for a high prevalence of consanguineous marriages (Sanghvi, 1966, 1974, Rao and Inbaraj, 1977, 1979, Bittles et al. 1991, Reddy, 1992, Reddy and Modell, 1995, Murty and Rao, 1996). An endogamous population, "Relli" , with well defined sub divisions, viz. , Chachati Relli and Kapu Relli, with a high frequency of sickle cell gene, is known (Krishanamurthy, 1971). The population has shown significant deviation from the Hardy-Weinberg equilibrium with respect to hemoglobin locus (Ramana et al. 1997). The Rellis are distributed in the north coastal districts of Visakhapatnam, Vizianagaram and Srikakulam, East Godavari, and West Godavari, and number around 28,000 according to the 1981 census of India. Thustron (1909) described the ethnography of the group and noted the primary occupation of Rellis to be fruit and vegetable vending. However, following the great famine of 1874 -1876, a group of them took up scavenging and other menial jobs for livelihood and were segregated. The splinter group is known as Chachati Relli, while the other group is identified as Kapu Relli. Both groups are clearly and distinctly endogamous and retain their occupations even today. The Kapu Relli enjoys a higher social status than Chachati Relli.

In the present study, we have estimated the genetic load using the regression of inbreeding on the prereproductive mortality rates of couples with different hemoglobin patterns so as to determine the segregation of recessive lethals in association with the sickle cell gene.

MATERIALS AND METHODS

Eighty-nine Chachati Relli and 132 Kapu Relli couples were selected from five localities of Visakhapatnam and Andhra Pradesh for the present study. Each couple was interviewed personally to elicit information on the type of marriage and number of livebirths and prenatal and prereproductive mortality. The effect of inbreeding on prereproductive mortality was assessed using the exponential model $L = A + BF$. Estimates of A and B have been obtained by the weighted regression (Smith, 1967) of the proportion of

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mortality (Li) on the in breeding coefficient (F) of the i^{th} class. The components of A and B are used to estimate the number of lethal equivalents (A+B) and the B/A ratio, which is useful to delineate the relative importance of segregational and mutational load in maintaining the hereditary burden of the population (Morton et al. 1956). The effect of inbreeding on the incidence of livebirths per couple and prereproductive mortality per couple was tested by the chisquare test of significance (Snecdor and Cochran, 1987).

Blood samples were obtained from all the family members to determine their hemoglobin genotype. Electrophoresis was carried out on celluloseacetate plates using Tris-EDTA-Boric acid buffer (pH 8.6) following Ellis and Alperin (1977). The population showed the presence of all three genotypes Hb AA (normal), Hb AS (Sickle cell trait) and Hb SS (Sickle cell homozygote).

RESULTS AND DISCUSSION

Consanguinity

Table 1 presents data on the distribution of marriage types in the two Relli subpopulations. The frequency of consanguineous marriages is higher in Chachati Relli than in Kapu Relli, possibly due to small population size. In the two subgroups, marriages between first cousins (MBD, FSD) are predominant, followed by second cousins in Chachati Relli; marriages between first cousins once removed and between second cousins show equal frequency in Kapu Relli. The average coefficient of inbreeding for autosomal genes (Fai) is 0.0246 and 0.0215 in Chachati Relli and Kapu Relli, respectively. In South India, and particularly in Andhra Pradesh, marriages between uncle-niece and cross cousins are preferential/prescribed forms of marriage. The inbreeding coefficient values obtained in the two Relli subpopulations seem to be identical to Vadde, a fishing caste population of Andhra Pradesh (F = 0.0220, Reddy, 1992), but lower than other caste populations (F = 0.0330, Sanghvi 1976).

Table 1. Consanguinity in the two Relli sub populations

Marriage type	Chachati Relli		Kapu Relli	
	No	percent	No	percent
Uncle-niece	0		3	2.27
1/2 Uncle-niece	1	1.12	1	0.76
Double first cousins	1	1.12	0	
First cousins	17	19.10	19	14.39
First cousins once removed	6	6.74	11	8.33
Second cousins	11	12.36	10	7.58
Parental consanguinity	8	8.99	7	5.30
Unrelated	45	50.56	81	61.36
	89	99.99	132	99.99

Fertility and mortality

The fertility and mortality patterns in couples with normal hemoglobin genotypes and with sickle cell gene in Chachati Relli and Kapu Relli are presented in Table 2. Due to limitations in the sample size of consanguineous couples, the data could not be subclassified into different inbreeding classes. Fertility in terms of livebirths in the two sub-populations is higher for consanguineous couples with different hemoglobin mating types than for non-consanguineous couples ; however, the differences are not significant. Similarly, the prereproductive mortality is higher in the progeny of consanguineous marriages than in non-consanguineous ones. However, these differences are not statistically significant, either. The enhanced fertility observed in consanguineous couples is probably to compensate for the increased mortality arising due to homozygotes for recessive lethals apart from sickle cell gene. Similar results were also obtained by Reddy and Modell (1995) with the Baiga tribe of Madhya Pradesh, and Reddy (1992) in Vadde, a fishing caste population of Andhra Pradesh.

Mortality and parental hemoglobin pattern

To identify whether any recessive lethals are segregated along with the sickle cell gene or independently, the mortality rates among the children of consanguineous and non-consanguineous parents with different hemoglobin patterns were estimated. Elevated mortality was observed in the progeny of consanguineous couples of AA x AA and AA x AS mating in Chachati Relli, and AA x AA mating in Kapu Relli. The elevation of mortality in the children of consanguineous couples with normal hemoglobin patterns could be due to the segregation of recessive lethals independent of the sickle cell gene. Sanghvi (1976) propounded that mortality differences between the progeny of consanguineous and non-consanguineous couples were due to the expression of

recessive lethals. On the other hand, the mortality rate was reduced among inbred offspring of AS x AS matings in Chachati Relli.

Genetic load

Genetic load is essentially a quantity designed to measure loss resulting from selection against deleterious homozygotes (Cavalli-Sforza and Bodmer, 1971). Table 3 presents the estimates of A and B for the genetic load in Chachati Relli and Kapu Relli. The estimate of A due to random mating and environmental factors is higher than the inbred load in Chachati Relli, thereby indicating the possibility of such factors. The B/A ratio in Chachati Relli is low, thereby suggesting that the nature of the genetic load is segregational. Further, the high mortality observed in inbred children unequivocally supports the segregational nature of the genetic load. Another observation made in the present study is the negative B value in Kapu Relli. This could have been largely due to a lack of variation in mortality in non inbred groups or due to sampling fluctuations. Reddy (1992), in his study on the genetic load for over 40 populations from South India, reported an average B value of 0.383(range -0.9 -1.37) and an average B/A ratio of 2.1(range -6.5 -14.3).

Further studies on this population to identify the selection intensity operating under inbreeding and the other confounding effects on mortality will be undertaken.

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Table 3. Estimates of Genetic Load in two Relli subpopulations

Population	A	B	B/A
Chachati Relli	1.4431	0.7064	0.4895
Kapu Relli	0.9479	-1.1415	-1.2042

Table 2. Fertility and mortality in sickle cell parental genotypes in Relli sub-populations

		Chachati Relli						Kapu Relli					
Parental Genotype	Marriage type	No. of couples	No. of live births	Mean live births/ couple	Mortality (<15 yrs)	Mean Mortality /couple	χ^2	No. of couples	No. of live births	Mean live births/ couple	Mortality (<15 yrs)	Mean Mortality/ couple	χ^2
AA X AA	C	9	33	3.67	10(0.303)	1.11	0.9854	28	115	4.11	12(0.104)	0.43	3.4150
	NC	15	54	3.60	10(0.185)	0.67		43	145	3.37	6(0.041)	0.14	
AA X AS	C	24	93	3.88	25(0.269)	1.04	3.7033	19	73	3.84	6(0.082)	0.32	1.6031
	NC	22	80	3.64	10(0.125)	0.45		31	118	3.81	18(0.153)	0.58	
AS X AS	C	10	49	4.90	15(0.306)	1.50	0.3497	4	22	5.50	7(0.318)	1.75	0.0710
	NC	7	49	7.00	19(0.388)	2.71		6	27	4.50	10(0.370)	1.67	
SS X AA	C	1	3	3.00	0	-		-	-	-	-	-	
	NC	1	2	2.00	0	-		1	2	2.00	-	-	
TOTAL	C	44	178	4.05	50(0.281)	1.14		51	210	4.12	25(0.119)	0.49	
	NC	45	185	4.11	39(0.211)	0.87		81	292	3.60	34(0.116)	0.42	
GRAND TOTAL		89	363	4.08	89(0.245)	1.00	1.465	132	502	3.80	59(0.118)	0.45	

C, consanguineous; NC, non consanguineous
(Figures in paranthesis are proportions)

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