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Inbreeding effects on fertility and sterility in southern India [1]

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SUMMARY The effects of consanguineous marriages on couples' fertility and sterility were explored through an interview survey of 20 626 women, chosen randomly from the rural and urban areas of the North Arcot District of Tamil Nadu State. Qualified women investigators obtained relevant information about reproductive performances of all married women resident in well defined rural and urban samples chosen randomly from North Arcot District. For each marriage, a family pedigree was drawn, extending upwards to two earlier generations on both sides of each spouse, in order to determine the existence and type of consanguinity involved. Of marriages in rural areas, 46·9% were consanguineous, and in urban areas, 29·1%. In more than 80% of the consanguineous marriages, the spouses were first cousins or more closely related. The extent of primary and secondary sterility and the level of fertility were examined in relation to each type of consanguineous marriage with the duration of the marriage and the age of the woman.

The frequency of primary sterility appeared to be lower in the consanguineous marriages compared to that in the non-consanguineous marriages. However, the differences were only marginal and only occasionally attained statistical significance. No trends were seen in the degree of consanguineous relationship, and there did not appear to be any association with the duration of marriage or the age of the woman.

The frequencies of secondary sterility did not differ significantly in consanguineous marriages in either the rural or the urban areas. No consistent associations were observed with degree of relationship. There were no specific associations in terms of the duration of marriage or the age of the woman observed in the frequencies of secondary sterility.

The mean levels of fertility were slightly raised among the consanguineous marriages and attained significance merely because of the large sample sizes involved.

These findings are discussed and compared with relevant published work. Comparisons are made difficult because of paucity of data based on community studies, and also because great differences exist in the methodology adopted by various investigators. The findings from the present study seem to show that long-term inbreeding results in only marginal or non-significant effects on fertility of inbred populations.

Published reports on the heritability of fertility and on variations in fertility among inbred families are few and inconclusive (Pearson *et al.*, 1899; Imaizumi *et al.*, 1970; Williams and Williams, 1974). Variations in fertility and sterility can be caused by several environmental factors or by specific genetic mechanisms. While some of these factors lead to greater reproductive losses and incapacity to conceive because of selection against particularly lethal genes, others, such as blood group compatibility, result in higher fertility, especially among inbred groups.

In exploring the relationship of inbreeding to fertility, it is necessary to consider both the extent and the duration of the practice of consanguinity, so as to distinguish between short term and long term effects (Sanghvi, 1966). In contrast to any other part of the world, consanguineous marriages are quite popular in south India, the practice dating back several centuries (Rao *et al.*, 1972). This situation provided an opportunity to explore the long term effects of inbreeding on several facets of human

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reproduction and development. An earlier paper dealt with inbreeding effects on reproductive losses and congenital malformations, on the basis of a comprehensive community study carried out in Tamil Nadu State during 1969 to 1975 (Rao and Inbaraj, 1977a). In this paper the effects of consanguineous marriages on couples' fertility and sterility are described.

Materials and methods

The study was carried out in one of the 14 districts in the state of Tamil Nadu (formerly known as Madras State). This district (North Arcot) has a population of 3·76 million (Tamil Nadu District Census, 1971) in about 14 taluks. Each taluk has 4 to 5 rural administrative sub-units known as Panchayat Unions or Community Development Blocks. One such Panchayat Union (K. V. Kuppam Block) in Gudiyatham Taluk was chosen as the rural sample. A random selection of representative segments of Vellore town, the headquarters of North Arcot District, provided the urban sample. The demographic characteristics of the district are fairly typical of those in other parts of the state. The principal local language is Tamil. In both the rural and urban areas, 85 to 90% of the population are Hindus, about 8% are Muslims, 2% are Christians, and roughly 1% belong to other religious groups (mostly Jains and Buddhists). The predominant occupation is agriculture and the literacy rate is only 35%.

Women interviewers, who were fluent in the local language (Tamil), and who had undergone the auxiliary-nurse midwives' course or some other basic course in health science, were appointed and given intensive training for the research project and in interview methods. Each interviewer was responsible for about 4000 people in the rural area and about 5000 in the urban area. For every 4 interviewers, there was a supervisor (female) and a co-ordinator (male).

The first stage of the study concentrated on mapping all houses and identifying each family. All the married women in these families were initially interviewed for general demographic details, and at subsequent visits subjected to an intensive interview, using a special questionnaire, to elicit information on:

(a) ages at puberty, marriage, and consummation of marriage;
(b) consanguinity of marriage; and
(c) details on each of past pregnancies, their outcome, and the survival of the offspring.

The investigators were given thorough training in drawing of family pedigrees and on interview techniques required to obtain data on consanguinity. If there was a consanguineous marriage, a pedigree was drawn extending upwards to two earlier generations on both sides of each spouse. This diagram was checked by the woman, and by at least one other adult familiar with the couple. Several pedigree diagrams depicting various degrees of closeness of relationship were drawn and given to each investigator for reference. On the basis of reinterview by supervisory personnel, it was found that misclassification of a consanguineous marriage as non-consanguineous or vice versa was practically zero. Similarly, misclassification of uncle–niece and first cousin marriage were rare. Only for relationships beyond that of first cousin were there some minor discrepancies. In the present analyses, all consanguineous types beyond that of first cousin matings have been grouped into one class.

Great emphasis was placed on obtaining information on every pregnancy and not just on those ending in a live birth. This required great patience and considerable tact as well as competence on the part of the investigator. Various kinds of memory aids were used to assist in identification of every pregnancy or to check the sequence of reported pregnancies. Significant events in the life of the woman and of members of her family, ages of her children now surviving, and their educational or occupational status were used in the conversation to finally determine the total of all pregnancies.

Of all married women, 5% were reinterviewed by supervisory personnel. Relevant data were coded, transferred to 80-column punch cards, and processed through IBM computer systems.

Definitions

Any married woman who had not produced a liveborn baby after consummation of marriage and unprotected sexual activity was considered to have 'primary sterility'. Any married woman who had no issue after the first liveborn baby, despite continuance of marriage and unprotected sexual activity, was considered to have 'secondary sterility'. The total number of live births that a woman had produced was taken as her level of fertility. The mean number of all live births in a group was taken as the average fertility for that group. All these indicators were further classified in terms of the age of the woman and the duration of her married life.

Results

The average inbreeding coefficients in the rural and urban areas were 0·0371 and 0·0204, respectively;

Table 1 *Number of women studied by type of consanguinity and duration of marriage: rural and urban*

Relationship	*Duration of marriage (y)*					*Total*
	0–4	*5–9*	*10–14*	*15–19*	*20 or more*	
Rural						
Non-consanguineous	1395	1076	996	727	1975	6169
Consanguineous	1106	945	920	761	1727	5459
Beyond first cousins	176	122	119	109	206	732
First cousins	555	504	461	401	965	2886
Uncle–niece	375	319	340	251	556	1841
Total	2501	2021	1916	1488	3702	11 628
Urban						
Non-consanguineous	1605	1277	1160	848	1488	6378
Consanguineous	594	511	447	380	688	2620
Beyond first cousins	117	89	89	57	106	458
First cousins	348	308	258	241	418	1573
Uncle–niece	129	114	100	82	164	589
Total	2199	1788	1607	1228	2176	8998

Table 2 *Number of women studied by type of consanguinity and year of birth: rural and urban*

Relationship	*Year of birth*					*Total*
	Before 1920	*1920–1929*	*1930–1939*	*1940–1949*	*1950 and later*	
Rural						
Non-consanguineous	1012	689	1254	2036	1178	6169
Consanguineous	675	670	1326	1862	926	5459
Beyond first cousins	72	81	184	250	145	732
First cousins	360	381	716	962	467	2886
Uncle–niece	243	208	426	650	314	1841
Total	1687	1359	2580	3898	2104	11 628
Urban						
Non-consanguineous	665	662	1625	2441	985	6378
Consanguineous	254	314	661	955	436	2620
Beyond first cousins	38	44	111	178	87	458
First cousins	151	199	409	559	255	1573
Uncle–niece	65	71	141	218	94	589
Total	919	976	2286	3396	1421	8998

Table 3 *Percentage of women with primary sterility by consanguinity and duration of marriage: rural and urban*

Relationship	*Duration of marriage (y)*				
	0–4	*5–9*	*10–14*	*15–19*	*20 or more*
Rural					
Non-consanguineous	62·1	10·6	5·0	3·9	3·7
Consanguineous	64·1	10·2	3·5	3·7	3·1
Beyond first cousins	71·4	10·3	3·5	2·9	2·0
First cousins	63·5	6·8	4·1	4·2	3·4
Uncle–niece	61·5	15·3	2·8	3·3	3·0
Total	63·0	10·4	4·3	3·8	3·4
Urban					
Non-consanguineous	54·3	12·1	9·2	5·9	4·8
Consanguineous	61·3*	13·4	6·0*	5·6	3·6
Beyond first cousins	56·4	16·7	6·0	7·4	2·0
First cousins	62·1	12·1	5·4	4·9	4·3
Uncle–niece	63·3	11·2	7·4	6·6	2·6
Total	56·2	12·3	8·3	5·8	4·4

*Difference between non-consanguineous and consanguineous significant, $P<0·05$, Fisher's Exact Test.

Table 4 *Percentage of women with primary sterility by consanguinity and age of woman: rural and urban*

Relationship	*Year of birth*				
	Before 1920	*1920–1929*	*1930–1939*	*1940–1949*	*1950 and later*
Rural					
Non-consanguineous	4·9	5·2	5·3	14·5	71·7
Consanguineous	3·3	3·9	3·6	11·3	70·8
Beyond first cousins	1·4	2·5	4·3	8·8	82·1
First cousins	2·8	3·7	4·3	10·3	69·0
Uncle–niece	4·5	4·8	2·1	13·7	68·5
Total	4·3	4·6	4·5	13·0	71·3
Urban					
Non-consanguineous	6·9	5·3	8·8	19·5	66·2
Consanguineous	5·1	5·7	5·0	16·8	65·1
Beyond first cousins	5·3	4·5	6·3	18·0	59·8
First cousins	5·3	6·0	4·6	16·3	66·7
Uncle–niece	4·6	5·6	5·0	17·0	66·0
Total	6·4	5·4	7·7	18·7	65·9

these are significantly higher than the rates prevalent in most parts of the world. Of the total number of marriages, 47% of the rural and 29% of the urban were consanguineous. In more than 80% of the consanguineous marriages, the spouses were first cousins or more closely related (Rao and Inbaraj, 1977b).

Women observed in the several types of consanguineous marriage are presented by the duration of marriage in Table 1, and by their age groups (birth cohorts) in Table 2. The percentages of sterility among the women by type of consanguinity and by duration of marriage are shown in Table 3.

Nearly 60% of the women who had been married for less than 5 years had not yet produced a liveborn baby. For marriages of 5 to 10 years' duration, the frequency was only 10%, and beyond 10 years of marriage, the frequency was around 4% in the rural and 6% in the urban areas. Considering all durations, the sterility in the consanguineous marriages was lower by only 3% in the rural and 1% in the urban as compared to the non-consanguineous marriages. Because of the large sample sizes involved, the difference in the rural area attained statistical significance ($P<0{\cdot}01$). Analyses by degree of consanguinity revealed no monotonic change, with the first cousin marriages showing the lowest frequency of primary sterility. Within each duration, no significant difference existed between consanguineous and non-consanguineous groups, nor were any consistent monotonic changes seen by degree of consanguinity. Thus, for women married 20 years or more the frequency of primary sterility was lower in the consanguineous than in the non-consanguineous, but the differences were not statistically significant. It is worth noting, however, the differences were much narrower in the rural than those seen in the urban area.

The frequencies of primary sterility by the age group of women and type of consanguineous marriage are given in Table 4.

In all of the birth cohorts in the rural area, and all but one in the urban, the frequency of primary sterility was less in the consanguineous marriages than that in the corresponding non-consanguineous

Table 5 *Percentage of women with secondary sterility by consanguinity and duration of marriage: rural and urban*

Relationship	*Duration of marriage (y)*				
	0–4	*5–9*	*10–14*	*15–19*	*20 or more*
Rural					
Non-consanguineous	28·7	22·3	6·1	4·8	5·1
Consanguineous	27·6	23·1	6·3	4·5	4·2
Beyond first cousins	23·8	17·2	3·5	2·9	4·1
First cousins	28·0	23·0	4·3	4·7	3·7
Uncle–niece	28·8	25·4	10·1	5·0	5·0
Total	28·2	22·7	6·2	4·7	4·7
Urban					
Non-consanguineous	32·8	16·9	8·1	6·4	4·6
Consanguineous	29·4	19·9	10·2	5·9	5·1
Beyond first cousins	32·7	10·7	8·3	1·9	4·0
First cousins	28·1	18·3	11·2	6·2	4·8
Uncle–niece	29·8	27·1	9·6	7·9	6·5
Total	31·9	17·5	8·7	6·3	4·8

Table 6 *Percentage of women with secondary sterility by consanguinity and age of woman: rural and urban*

Relationship	*Year of birth*				
	Before 1920	*1920–1929*	*1930–1939*	*1940–1949*	*1950 and later*
Rural					
Non-consanguineous	6·8	6·7	4·9	19·6	20·0
Consanguineous	6·5	6·3	3·4	19·1	20·6
Beyond first cousins	2·8	8·6	4·3	17·2	13·8
First cousins	5·8	5·5	3·6	18·4	21·8
Uncle–niece	8·6	6·7	4·9	20·9	22·0
Total	6·7	6·5	4·5	19·4	20·3
Urban					
Non-consanguineous	7·1	6·5	6·7	20·7	22·9
Consanguineous	8·7	4·8	5·6	19·2	25·5
Beyond first cousins	10·5	4·5	6·3	13·5	29·9
First cousins	5·3	4·5	6·1	19·3	23·5
Uncle–niece	15·4	5·6	3·5	23·4	26·6
Total	7·5	5·9	6·4	20·2	23·7

group. However, the differences attained statistical significance only occasionally.

The extent of secondary sterility by type of consanguinity and in the various durations of marriage are presented in Table 5.

The frequency of secondary sterility was around 30% for marriages of less than 5 years, declining to about 20% among those married for 5 to 10 years, and remaining at 5 to 6% thereafter. There were no significant differences in the frequencies of secondary sterility among the consanguineous and non-consanguineous marriages, either in the rural or in the urban areas. Among the various consanguineous marriages, it appears that the frequencies increase as the relationship becomes closer; however, the differences do not attain statistical significance. The frequencies of secondary sterility within each group based on duration of marriage show that there was hardly any significant difference between the consanguineous and non-consanguineous marriages.

Similar analyses by birth cohorts (Table 6) showed hardly any significant differences in the frequencies of secondary sterility by type of consanguinity.

The mean numbers of pregnancies, live births, and living children per woman in the different types of consanguineous marriages in the rural and urban areas are given in Table 7.

In the rural area, the first cousin marriages showed the highest values for all the three, and with the large sample sizes these differences are statistically significant. In the urban area, the first cousin marriages showed no such excess over the other types. When all of the consanguineous marriages are taken together, significant differences exist only for the number of pregnancies and the number of live-born babies in the rural group.

The mean levels of fertility, considering only the number live-born by type of consanguineous marriage among women with varying durations of marriage, are shown in Table 8.

No clear cut or uniform pattern can be discerned. However, in most of the groups, the highest value is seen for the first cousin matings. There are no consistent trends according to the degree of consanguineous marriage, and, in most instances, the differences are not statistically significant. In general,

Table 7 *Mean numbers (± SE of mean) of pregnancies, live births, and living children per woman by type of consanguineous marriage: rural and urban*

Relationship	*Women observed*	*Pregnancies*			*Live births*			*Living*		
		No.	*Mean*	*SE*	*No.*	*Mean*	*SE*	*No.*	*Mean*	*SE*
Rural										
Non-consanguineous	6169	20 606	3·3	0·04	20 010	3·2	0·03	15 646	2·5	0·03
Consanguineous	5459	19 438	3·6*	0·04	18 708	3·4*	0·04	14 064	2·6	0·03
Beyond first cousins	732	2607	3·6	0·11	2504	3·4	0·10	1902	2·6	0·08
First cousins	2886	10 722	3·7	0·05	10 348	3·6	0·05	7743	2·7	0·04
Uncle–niece	1841	6109	3·3	0·06	5856	3·2	0·06	4419	2·4	0·05
Urban										
Non-consanguineous	6378	21 116	3·3	0·04	19 735	3·1	0·03	15 352	2·4	0·03
Consanguineous	2620	9001	3·4	0·06	8421	3·2	0·05	6276	2·4	0·04
Beyond first cousins	458	1512	3·3	0·13	1405	3·1	0·13	1084	2·4	0·10
First cousins	1573	5488	3·5	0·07	5163	3·3	0·07	3823	2·4	0·05
Uncle–niece	589	2001	3·4	0·12	1853	3·2	0·11	1369	2·3	0·09

*Difference between non-consanguineous and consanguineous significant, $P<0·05$, normal test.

Table 8 *Mean number (± SE of mean) of live-born per woman by consanguinity and duration of marriage: rural and urban*

Relationship	Duration of marriage (y)									
	0–4		5–9		10–14		15–19		20 or more	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Rural										
Non-consanguineous	0·50	0·02	2·03	0·04	3·48	0·05	4·54	0·08	5·43	0·06
Consanguineous	0·47	0·03	1·99	0·04	3·53	0·05	4·59	0·07	5·63	0·07
Beyond first cousins	0·35	0·05	2·11	0·11	3·82	0·13	4·64	0·18	5·97	0·19
First cousins	0·49	0·03	2·10	0·05	3·66	0·07	4·71	0·11	5·77	0·09
Uncle–niece	0·52	0·05	1·79	0·07	3·27	0·08	4·39	0·12	5·28	0·12
Urban										
Non-consanguineous	0·62	0·02	2·15	0·03	3·33	0·06	4·41	0·08	5·64	0·08
Consanguineous	0·51	0·04	2·13	0·05	3·43	0·08	4·48	0·12	5·47	0·11
Beyond first cousins	0·57	0·07	2·01	0·13	3·42	0·18	4·80	0·36	5·60	0·27
First cousins	0·52	0·05	2·04	0·07	3·50	0·12	4·56	0·15	5·40	0·14
Uncle–niece	0·44	0·06	2·01	0·13	3·27	0·18	4·03	0·24	5·56	0·22

the mean numbers are lower for both the uncle–niece and non-consanguineous marriages than for the first cousin and beyond first cousin matings.

When studied by the birth cohort of the woman (Table 9) the above patterns are further confirmed, especially in women of the earliest birth cohort.

These trends are more uniformly seen in the rural than in the urban areas, where the differences are not so pronounced between the various types of consanguineous marriages.

Discussion

Divergent views are held by various investigators who have explored the relationship of inbreeding to sterility and fertility. These conclusions are obscured because of the great diversity of methods and indices used. On the basis of data obtained through correspondence in the USA with 'reputable' private physicians, Bemiss (1858) concludes that consanguinity results in low fertility. That this might possibly be due to the fact that nearly a third of the children were in some way defective, and the parents in many cases far below the average in vitality, has not been seriously considered. Two other studies in the USA, one based primarily on genealogies (Arner, 1908) and the other using Catholic parish records (Slatis *et al.*, 1958), conclude that consanguinity does not influence fertility. Though there is a high degree of inbreeding in such groups as the Amish and Hutterites, there appear to be no adverse effects, and in fact an increase in fertility can be seen (Eaton and Mayer, 1954; Cross and McKusick, 1970).

While Darwin (1875), using genealogical data in England, found a higher degree of sterility as well as of fertility in the consanguineous than in the non-consanguineous marriages (though not statistically significant), Darlington (1960), who compared the reproductive performance of descendants of cousin marriages and of matching controls, concludes that, (1) human stocks can maintain not only their greatest uniformity, but also their highest fertility with regular cousin marriages, and (2) the change to inbreeding provides the best possible means of selection for high fertility. On the basis of further

Table 9 *Mean number (± SE of mean) of live-born per woman by consanguinity and age of woman: rural and urban*

Relationship	Year of birth									
	Before 1920		1920–1929		1930–1939		1940–1949		1950 and later	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Rural										
Non-consanguineous	5·13	0·09	5·18	0·11	4·65	0·06	2·43	0·04	0·41	0·02
Consanguineous	5·53	0·11	5·31	0·10	4·81	0·06	2·51	0·04	0·40	0·02
Beyond first cousins	6·14	0·32	5·64	0·32	4·80	0·16	2·74	0·11	0·26	0·51
First cousins	5·86	0·15	5·45	0·14	4·85	0·08	2·58	0·05	0·43	0·03
Uncle–niece	4·86	0·18	4·90	0·18	4·75	0·11	2·30	0·06	0·42	0·04
Urban										
Non-consanguineous	5·28	0·12	5·41	0·11	4·27	0·06	2·14	0·03	0·50	0·25
Consanguineous	5·37	0·19	5·28	0·15	4·60	0·09	2·26	0·08	0·46	0·03
Beyond first cousins	5·26	0·50	5·52	0·42	4·52	0·25	2·33	0·13	0·53	0·08
First cousins	5·66	0·25	5·27	0·19	4·60	0·11	2·26	0·07	0·45	0·05
Uncle–niece	4·77	0·40	5·16	0·34	4·65	0·19	2·20	0·12	0·44	0·07

studies, Darlington (1961) concludes that the effects of fertility (or of infertility) are cumulative, and that there will be a depreciation of fertility after outbreeding in an inbred stock. Book (1957) reported a higher fertility among Swedish first cousin marriages compared to controls. The lower value among the controls can perhaps be explained by the fact that the manner of selection of controls resulted in a younger group than the consanguineous parents. Studies done in rural France, based on church records of marriage, showed no significant differences between consanguineous and non-consanguineous marriages in terms of fertility or sterility (Sutter and Tabah, 1953). Similarly, studies of Kurdish Jews (Goldschmidt *et al.*, 1963) and studies in Canada (Philippe, 1973) found no inbreeding effects on fertility.

Geographical studies of consanguineous marriages, as opposed to studies based on church records or specific population isolates, are relatively rare. One significant study was based in Hiroshima and Nagasaki in Japan (Schull and Neel, 1965), and a further extension in another area, Hirado (Schull *et al.*, 1970). The Japanese studies showed that the total pregnancies and total live births increased significantly with parental consanguinity, but that 'net fertility', defined as the 'total live births minus non-accidental deaths prior to the age of 21 years', did not. Another study in Brazil (Freire-Maia and Azevedo, 1971) reported higher fertility among consanguineous marriages, but attributed this differential to the longer mean cohabitation time for the consanguineous couples compared to the controls. In a more recent communication, Freire-Maia and Krieger (1975) confirm the lack of appreciable inbreeding effects of fertility.

Thus, while some earlier studies observed significant changes in fertility or in sterility as a result of inbreeding, more recent studies find little support for such a hypothesis. Interpretations are made difficult because of differences in age and marital factors in the groups under comparison, and in the methodology adopted. The present studies do not show any significant effects of inbreeding on sterility or fertility. It is possible that those offspring who are defective or affected in some way do not attain reproductive age, or do not get married, thereby leaving those who are normal or have above average fertility to continue reproduction. However, such events appear to be too few to materially alter the lack of significant inbreeding effects.

Sterility in humans may occur because of the production of lethal genotypes, but such instances should be rare (Stern, 1960). More common causes are the absence of normal ova or sperm, or circumstances which prevent fertilisation even though normal gametes are present, or lack of normal development of the embryo. Though non-genetic factors cannot be precluded in such phenomena, the role of genetics cannot be underlined. Thus, specific alleles at various genic loci may be responsible for the non-formation of ova and sperm, and for the development of abnormal genitalia, or for any physiological condition in the female which prevents the development of viable offspring. Loss of fetuses and inability to continue a pregnancy successfully can be a function of abnormal genes or of chromosomal aberrations. Not all genetic effects need be harmful, but the beneficial effects are often not discovered.

The role of reproductive compensation in the maintenance of genetic variability was first suggested in the context of the Rh blood-group system (Race, 1944; Reed, 1971). Studies at Hirado, Japan have provided cogent reasons for considering reproductive compensation as an important factor in the increase in fertility to match the reproductive losses caused by genes, thereby making the net fertility more or less the same between consanguineous and non-consanguineous marriages (Schull and Neel, 1972). It is possible that because of the high infant and early childhood mortality, reproductive compensation takes place. However, in the present studies only marginal differences are noted between consanguineous and non-consanguineous matings in terms of fetal or infant losses. These differences attain statistical significance mainly because of the very large samples involved; otherwise they may not have much practical significance. If reproductive compensation exists, then there is likely to be an almost full replacement of defective persons, and consequently a reduction in the frequencies of recessive lethal genes. The situation in south India may thus reflect the effects of long term inbreeding, as distinguished from the short term effects documented in inbred populations. Further evaluation of the long term aspects of continued inbreeding, especially when reproductive compensation exists, is, however, necessary before drawing conclusions on the gene influences in the production of deleterious effects among the offspring of consanguineous matings.

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