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Articles

Reproductive Behavior and Health in Consanguineous Marriages

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In many regions of Asia and Africa, consanguineous marriages currently account for approximately 20 to 50% of all unions, and preliminary observations indicate that migrants from these areas continue to contract marriages with close relatives when resident in North America and Western Europe. Consanguinity is associated with increased gross fertility, due at least in part to younger maternal age at first livebirth. Morbidity and mortality also may be elevated, resulting in comparable numbers of surviving offspring in consanguineous and nonconsanguineous families. With advances in medicine and public health, genetic disorders will account for an increased proportion of disease worldwide. Predictably, this burden will fall more heavily on countries and communities in which consanguinity is strongly favored, as the result of the expression of deleterious recessive genes. However, studies conducted in such populations indicate that the adverse effects associated with inbreeding are experienced by a minority of families.

FROM A WESTERN PERSPECTIVE, CONSANGUINEOUS MARriages often are regarded in a negative light and tend to be considered as rare events, essentially restricted to population isolates, with the strong possibility of abnormal progeny. To a large extent this viewpoint may be fostered by religious and secular constraints on first cousin marriages. For Roman Catholics, Diocesan dispensation is a prerequisite to Church solemnization of marriages between first cousins, and in the majority of U.S. states first cousin marriages are illegal (*1*) under statutes passed in the 19th and early 20th centuries.

The earliest systematic approach to an investigation of the relation between consanguinity and health was reported by Bemiss in 1858 in the United States (*2*). At much the same time Charles Darwin, having fathered ten children with his cousin Emma Wedgewood, became perturbed that the progeny of first cousins might be biologically disadvantaged. To investigate the subject he lobbied, without success, for the inclusion of a question on the numbers and effects of cousin marriage in the 1871 Census of Great Britain and Ireland (*3*). His son George adopted an alternative approach to the estimation of cousin marriage by enumerating unions between persons bearing the same surname, an early application of the technique of marital isonymy. Then, to quantify the effects of inbreeding on physique (*4*), he compared the incidence of first cousin progeny among oarsmen at the universities of Oxford and Cambridge (2.8%) with their nonsporting peers (3.5%).

Although interesting, this historical phase of investigation into consanguinity revealed little about the global extent of preferential marriage between close relatives. As it was aimed specifically at the identification of deleterious, biological aspects of such unions, it also failed to consider the important associated social, economic, and cultural perspectives.

Demographic, Genetic, and Social Aspects of Consanguinity

Many commentators have tacitly accepted that, even in countries or communities where marriages between close relatives formerly were commonplace, their incidence in recent generations has greatly declined. This supposition certainly holds true for North America and Western Europe, where the current incidence of marriage at first cousin level in the general population is approximately 0.5% (*5*), and to a lesser extent in Japan (*6*). But genetic and demographic studies show that within many other large human populations, numbering hundreds of millions, consanguineous marriages remain strongly favored. For example, in the mainly Muslim countries of northern Africa (7) and western Asia (*8*), in southern Asia (*9*), and in regions where large sections of the population are Muslim, including North, East, and Central India (*10*) and the middle Asian republics of the Soviet Union (*11*), marriages contracted between persons who are related as second cousins or closer account for between 20% and 55% of the total. In these Muslim societies, first cousin marriages predominate, with the partners having one set of grandparents in common, although occasionally double first cousin marriages (coefficient of inbreeding, $F = 0.125$) also are arranged, in which the couple share two sets of common grandparents. Parallel first cousin unions, with a father's brother's daughter (FBD), are particularly popular in Muslim communities. Genetically, the progeny of such a union would have a coefficient of inbreeding of 0.0625. That is, at 6.25% of autosomal loci they would be predicted to have inherited identical copies of a gene from both parents, who in turn would have inherited it from a common ancestor or ancestors. Although all first cousin unions have the same predicted F value for autosomal loci, the corresponding coefficient of inbreeding at X chromosome loci (F_x) may vary, dependent on the precise pattern of the marriage.

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Consanguinity is not restricted to Islamic societies and communities. On average 20 to 45% of marriages in the primarily Hindu states of South India are between close relatives, with uncle-niece ($F = 0.125$) and cross first cousin unions, usually mother's brother's daughter (MBD), especially preferred (*12*). Similarly, Buddhists, Christians, Jews, Parsees, and Druze living in southern and western Asian countries frequently marry close kin (*13*), presumably reflecting their acceptance and preference for the prevailing marriage norms. Manifestly, when considering the level of inbreeding cited for a population, and especially one with a long tradition of consanguinity, the cumulative depth of inbreeding would be expected to greatly exceed the F value calculated for a single generation.

Although data for other major populations are fragmentary, anthropological and ethnographic surveys have recorded 35 to 50% cousin marriages in the sub-Saharan region (*14*), the product both of traditional societal practices and Islamization. China represents a special problem in that little or no information appears to have been collected on consanguinity since the establishment of the People's Republic. Prior to World War II, marriage at first cousin level of the MBD pattern (termed "up the hill") was quite common among the Han, who make up some 90% of the total population (*15*), and marriage with a close relative was favored by many other groups, particularly the Muslim Uighur of Xinjiang province in the west of China. An indication that consanguinity has persisted among the Han, perhaps as a result of increased village and town endogamy during the 1960s and 1970s (*16*), was provided by a recent report in the newspaper *China Daily* on the proscription of cousin marriage in the northeastern province of Liaoning. Along with marriage between persons classified as physically or mentally handicapped, the ban on cousin marriage was to be introduced on "eugenic" grounds.

In populations favoring consanguineous unions, the highest rates of marriage to a relative usually are reported in rural areas and among the poorest and least educated community members (*17*). A partial exception to this generalization is land-owning families, which use consanguineous marriages to maintain the integrity of their landholdings (*18*). The association between consanguinity and socioeconomic position complicates study of the genetic effects of human inbreeding. If any of the measured outcomes of consanguinity are more likely to occur among the poorest and least educated, then failure to account for socioeconomic status can lead to overestimation of the effects of inbreeding. For example, in a large survey in Japan, inflation of the apparent effects of inbreeding on continuously variable characteristics, including anthropometric measurements, was estimated at approximately 20% (*19*).

There often has been rather uncritical acceptance of data purporting to show the action of deleterious recessive genes, despite a paucity of information on the comparative socioeconomic status of consanguineous and nonconsanguineous groups. The problem may be further compounded by failure to apply rudimentary tests of statistical significance to the results of surveys on inbreeding, and automatic translation of the raw data into mean numbers of lethal and sublethal genes using regression on the proportion of survivors at different F values (*20*). The major reevaluation during the last four decades of alleles contributing to morbidity and premature death (*21*), with the estimated number of lethal and morbid gene equivalents per individual reduced from 5.0 to 2.0, provides some evidence of the degree to which variable protocols of data collection and analysis have influenced the assessment of inbreeding effects.

Consanguinity and Reproductive Behavior

Both biological and social considerations must be taken into account when judging the relation of consanguinity to reproductive behavior and fertility. From a biological viewpoint the sharing of common histocompatibility antigens by spouses, which is more likely in consanguineous marriages, has been claimed to be a contributory factor in failure to initiate pregnancy (*22*). The extent to which this occurs has been strongly queried (*23*), and reports from a number of different populations actually have demonstrated reduced levels of primary sterility in inbred marriages (*24*), usually interpreted as stemming from greater immunological compatibility of mother and fetus. There also is little convincing evidence linking inbreeding to increased rates of spontaneous abortion or stillbirths (*25*). However, post-implantation losses identified by human chorionic gonadotropin (hCG) assays have been estimated at 31% (*26*), with perhaps 50 to 80% of all conceptions failing to result in a livebirth (*27*). Thus, spontaneous abortions caused by the action of early-acting recessive genes may go undetected and the incidence of such genes be significantly underestimated. In terms of gross fertility, large-scale surveys conducted in many countries have indicated greater numbers of infants born to closely related couples (*28*), with no effect either on multiple birth rates (*29*) or on the sex ratio at birth of progeny (*29, 30*).

A variety of social factors is strongly implicated in the greater fertility of consanguineous marriages. In societies as diverse as Hindu South India and Muslim Lebanon, consanguineous marriages are thought to offer major advantages in terms of compatibility of the bride and her husband's family, particularly her mother-in-law, and the maintenance of family property (*31*). Because of family ties, marriage arrangements are less complicated, and in societies where bridewealth or dowry is the norm there is the additional economic incentive of greatly reduced or no payments in marriages between first cousins or closer relatives (*32*). Above all, in communities where households are highly self-contained, there is the conviction that the union of a son or daughter with a close relative offers the optimum marital choice, by avoiding hidden uncertainties regarding health or other important family characteristics which might not be revealed before marriage to a nonrelative.

Characteristically, union with a close relative enables earlier marriage and younger maternal age at first livebirth, factors which can increase both the pace of fertility and completed family size (*33*). It has been argued that the greater number of births in consanguineous marriages is in part a reproductive compensation response to increased early postnatal mortality (*34*), operating through a conscious decision by parents to achieve their desired family size or owing to the cessation of lactational amenorrhea following the death of a breast-fed infant. The younger age of consanguineous mothers at first livebirth, and possible adverse effects of gynecological immaturity on the developing fetus in utero (*35*), may be an important contributory component in the greater morbidity and mortality of their progeny. When each of these variables is taken into consideration, virtually all studies to date have reported no significant difference in the numbers of surviving children in consanguineous and nonconsanguineous families (*36*), which has important implications with respect both to the social acceptability of marriage to a close relative and the maintenance of deleterious recessive alleles in the population gene pool.

Consanguinity and Health

The deleterious health effects associated with consanguinity are caused by the expression of rare, recessive genes inherited from a common ancestor or ancestors. Therefore, in populations where inbreeding is widely practiced, increased levels of morbidity and mortality ascribable to the action of deleterious genes can be expected. Conversely, in populations in which outbreeding is the norm, the presence of marriage between close relatives in the

Table 1. Marital type by coefficient of inbreeding (F) and religion, Karnataka, 1980–1989.

Marital type	Religion (%)				Total (no.)
	Hindu	Muslim	Christian	Other	
Nonconsanguineous ($F = 0$)	62.0	72.9	78.1		69,153
Beyond second cousin ($F < 0.0156$)	4.5	3.5	3.4		4,632
Second cousin ($F = 0.0156$)	1.7	2.5	1.6		1,995
First cousin ($F = 0.0625$)	10.8	17.5	6.8		12,578
Uncle-niece ($F = 0.125$)	21.0	3.7	10.2		19,160
Total (no.)	86,448	17,019	4,038	13	107,518

pedigree of an affected individual frequently is cited as presumptive evidence for recessive inheritance of a rare disorder.

Many general impressions as to the effects associated with inbreeding stem from studies conducted on population isolates and minorities. But even in the absence of preferential consanguinity, alleles rare in large populations can increase to high frequency in small groups within a few generations, because of genetic drift in a breeding pool of restricted size. Representative examples of this phenomenon are Ellis van Creveld syndrome in the Amish (*37*) and von Willebrand disease in the population of the Åland Islands (*38*). To extrapolate from these now atypical groups, in which founder effect and genetic drift may be predominant, to continental populations is of questionable validity and little practical use.

In surveys based on larger regional populations, anthropometric measurements at birth and in childhood appear to be reduced by inbreeding only to a limited degree (*39*). Although marginal declines have been measured in the mean scores attained by consanguineous progeny in tests of intellectual capacity, the main effect of inbreeding is to produce greater variance in IQ levels (*40*), due in part to the expression of deleterious recessive genes in a small proportion of those tested. This failure to observe marked consanguinity effects in quantitative traits may primarily be a reflection of their polygenic, multifactorial nature, with homozygosity differentially affecting the expression of contributory genes in a mutually antagonistic manner.

The incidence of major congenital malformations is significantly higher in consanguineous progeny, as is postnatal mortality, which usually commences early in the first year of life. Because most communities that favor consanguineous marriage would be categorized as economically less developed, it may be difficult to specifically identify genetic disorders, and to determine their incidence, against prevailing high background levels of infectious and nutritional diseases. The use of relative risk measures (*41*) to describe the excess morbidity or mortality found with consanguinity has been proposed as an alternative to previous statistical methods, based on calculated lethal and sublethal gene equivalents (*20*). However, to minimize spurious interpretation of relative risks, it is essential that socioeconomic and other nongenetic variables be rigorously controlled. In percentage terms, current global estimates of major causes of morbidity in the progeny of first cousins range from an absolute excess of 1.3 to 4.1% compared to equivalent nonconsanguineous offspring (*42*), whereas mean prereproductive mortality at first cousin level is elevated by between 1.0 and 6.4% (*43*). To date, little information is available on adult morbidity or mortality rates, and hence the contribution of late-acting recessive genes, in consanguineous progeny.

A Case Study: South India

The results of a 10-year study based in the cities of Bangalore and Mysore in the state of Karnataka, South India, exemplify how a number of the factors thus far discussed can be related in a large population. The study was begun in 1980, with the aim of providing a presymptomatic, neonatal screening service for the detection of amino acidopathies in babies delivered in hospitals and nursing homes throughout the two cities (*44*). As no charge was levied for the test, excellent parental cooperation was forthcoming from the 111,624 mothers interviewed during the study period. At the time of blood sampling from the neonate, the mother was asked about her relatedness to her spouse and her reproductive history, age, and religion (*45*). All interviews were conducted in the mother's language by trained local staff.

Under ideal circumstances, the design of the study would have permitted complete enumeration of births in hospitals, clinics, and nursing homes in Bangalore and Mysore but this was not possible. Information could not be collected on births delivered outside organized medical settings, thought to account for up to 20% of all babies born in both cities. For the most part these births occur among the poorest sections of the community. Deliveries in some private clinics serving the wealthiest families also were underrepresented. Although the data set is not a probability sample, nor is it totally representative of the entire range and composition of the socioeconomic status distribution in the population, the ascertainment of consanguinity in combination with basic demographic variables for such a large number of marriages is unprecedented.

As indicated in Table 1, there were 107,518 marriages for which complete data were available. Defining consanguinity as marriage between second cousins or closer relatives, 31.4% of all unions were consanguineous, equivalent to a coefficient of inbreeding for the entire sample ($F = \Sigma\, p_i F_i$) of 0.0299. Consanguinity was most prevalent among Hindus (33.5%) and, because of their high rate of uncle-niece marriages, Hindus also had much the highest coefficient of inbreeding ($F = 0.0333$). Muslims avoided uncle-niece marriages, which are proscribed by the Koran, and when marrying a relative they mostly chose first cousin unions. Among Muslims 23.7% of marriages were consanguineous with $F = 0.0160$, just under half the value calculated for Hindus. Christians in Karnataka, including Roman Catholics, contracted both uncle-niece and first cousin marriages and so, although they had the lowest total percentage of consanguineous unions (18.6%), their coefficient of inbreeding was $F = 0.0173$.

The detailed questions addressed using the Karnataka data were whether differences existed by consanguinity in (i) mother's age at first birth, (ii) the mean number of children ever born, (iii) the log odds of a child dying versus no death, and (iv) among families experiencing child mortality, the log odds of two or more children dying versus exactly one death. The possibility of joint effects involving the interaction of religion with consanguinity was additionally considered.

Multivariate analyses were run in which the above outcome variables were estimated as functions of marriage type, religion, hospital type and, where appropriate, age. Three hospital types can be defined in Bangalore and Mysore, representing three different levels of bed charges: government hospitals, church and employment-based hospitals, and clinics and private nursing homes. Thus, hospital type can be used both to distinguish between the two cities and to provide a partial control for socioeconomic status. This latter strategy had to be adopted as, despite good rapport with the respondents, the collection of reliable, direct information on their financial status or socioeconomic background proved fruitless. To some extent the problem arose because of difficulties in accurately assessing differential socioeconomic status in a country with a gross national product per capita estimated in 1986 at $290 (*46*), but it was also due to reluctance on the part of mothers to discuss their financial status in case it would result in higher hospital bed charges. Given the basic project rationale, and the mothers' postpuerperal status, other socioeconomic data were not collected. Mother's age was controlled when examining cumulative fertility and infant and child mortality because fertility cumulates with age and the chances of having lost a child are greater for women who have had a longer period to experience the death of an infant.

Table 2 is compiled from two ordinary least squares (OLS) regression analyses and two logit regressions computed from the Karnataka data. The first regression treats mother's age at first birth as a function of marriage type, religion, their interaction, and hospital type. The OLS regression on maternal age at first birth (I) shows that the youngest women at first livebirth were Muslim, and Christians were the oldest. The more highly inbred couples had younger mean ages at first livebirth, with interaction between consanguinity and religion. OLS regression II treats cumulative fertility as a function of religion, consanguinity, their interaction, hospital type, and mother's age at the index birth. Muslims had higher fertility than Hindus or Christians, with increased fertility linked to all degrees of consanguinity. A Muslim-consanguinity interaction term captures the depressed fertility of the Muslim uncle-niece marriages proscribed by the Koran. This deviation from the consanguinity-fertility association has yet to be explained.

Infant and child mortality were modeled by first examining the log odds of no child dying versus the death of any progeny. Regression III shows that the loss of one or more children was more likely to be experienced by first cousin and uncle-niece couples. When multiple deaths versus one only were considered (regression IV), the marriage-type effect became larger, which is consistent with the hypothesis of a genetic etiology. However, it is important that the levels of mortality recorded for the population be kept in perspective. In this study, of the 63,489 families with two or more liveborn infants at the time of data collection, 7.9% had lost one child or more and two or more deaths were recorded in 3.0% of families. Without access to more informative socioeconomic and behavioral measures, and precise diagnoses on cause of death, it is not possible to assess the extent of any overstatement in the excess mortality observed in consanguineous families, or to partition the excess into primarily genetic or nongenetic components. Nevertheless, the assumption of a significant genetic component in observed childhood mortality is supported by the findings of an associated study, which specifically identified a wide range of recessively inherited disorders among children in the community (*47*).

Table 2. Dummy variable regressions for maternal age at first livebirth, number of liveborn children, and mortality. City and hospital type are treated as a single classification, with hospital type 1 in Bangalore as the reference category. Hospital 1, government hospitals; hospital 2, church and employment-based hospitals; hospital 3, clinics and private nursing homes. A blank entry means the variable is excluded from the regression; "–" denotes the reference category of a classification. The regression for age at first birth was computed by ordinary least squares and based on women delivering their first liveborn baby. Religion interacts with consanguinity (uncle-niece or first cousin versus any other degree, including unrelated). The regression for number of liveborn children was computed by ordinary least squares and excludes women aged 12 to 14 years of age. Religion interacts with consanguinity (Muslim uncle-niece marriages versus any other combination). The two mortality regressions were computed as logit regressions from maximum likelihood calculations provided by the GLIM 3.77 statistical software system. Women delivering their first liveborn baby are excluded, as are women aged 12 to 14 years. The first logit regression fits the log odds of one or more infant deaths (high) versus none (low). The second logit regression is nested within the first and fits the log odds of two or more infant deaths (high) versus one (low); it is computed separately.

Regressors	Dependent variables			
	Age at first birth (I)	Number of liveborns (II)	Mortality: 0 vs ≥1 (III)	Mortality: 1 vs ≥2 (IV)
Intercept	21.98‡	1.06‡	−2.00‡	−2.03‡
Religion				
Hindu	–	–	–	–
Muslim	−1.16‡	0.38‡	−0.16‡	−0.16
Christian	0.88‡	−0.07‡	−0.10	−0.40*
Consanguinity				
Unrelated	–	–	–	–
Second cousin	−0.84‡	0.17‡	−0.03	−0.45
First cousin	−1.10‡	0.18‡	0.10*	0.34‡
Uncle-niece	−1.41‡	0.20‡	0.20‡	0.21†
Interactions				
Hindu and consanguinity	–	–		
Muslim and consanguinity	0.55‡	−0.22‡		
Christian and consanguinity	−0.35	–		
Age				
15–19		–	–	–
20–24		0.73‡	−0.53‡	0.71‡
25–29		1.42‡	−0.64‡	1.13‡
30–34		2.00‡	−0.42‡	1.56‡
35–39		2.77‡	−0.10	1.77‡
40–44		3.46‡	−0.24	2.25‡
≥45		2.80‡	−0.20	0.92
Bangalore*				
Hospital 1	–	–	–	–
Hospital 2	−0.01	−0.09‡	0.70‡	0.01
Hospital 3	−0.82‡	0.36‡	−0.22‡	−0.15
Mysore				
Hospital 1	−0.20‡	0.00	0.49‡	0.18*
Hospital 2	0.09	0.13‡	0.58‡	−0.12
Hospital 3	0.97‡	−0.22‡	0.04‡	−0.03
Totals	36,856	100,294	63,489	5,712

*For reference purposes only, putative levels of significance (two-tail) are reported as *$P \le 0.05$, †$P \le 0.01$, and ‡$P \le 0.001$.

The age contrasts in regression II were as expected: fertility increased monotonically with maternal age. Those in the mortality equation for any versus no infant deaths (regression III) were less clear, because at least one infant death was most frequently reported by the youngest mothers (15 to 19 years) whereas it was least common among those aged 20 to 34. This finding may be indicative of the relative gynecological immaturity of mothers under 20 years of age. Alternatively, some mothers who had experienced the death of one or more children may have been unwilling to report it in the days immediately following the birth of their most recent child. Among those who did report the loss of one or more children, however, there was little hint of such reticence (regression IV). For those mothers, the odds of losing more than one child increased monotonically with age up to the oldest age group in the study (≥45 years), by which time recall error is thought to be in greatest evidence.

The combined contrasts for city and hospital type, present in all four regression analyses in Table 2, differed by city, which was unexpected. All other things being equal, because the government hospitals (type 1) primarily serve the poorest families and clinics and private nursing homes (type 3) serve the most affluent, then the highest age at first livebirth, the fewest liveborns, the lowest reporting of any mortality, and of multiple infant and child deaths, would be expected for type 3 units in both Bangalore and Mysore. In fact, there is the suggestion of a reversal across cities which may reflect their recent histories. In Bangalore, the burgeoning capital of

Karnataka, mothers giving birth in the more costly clinics and private nursing homes have, contrary to expectation, the lowest mean age at first livebirth and highest fertility, while at the same time reporting, consistent with prior expectation, the lowest likelihood of a child death and, among those who do report at least one death, the lowest likelihood of multiple child deaths. In Mysore, the former capital of Karnataka, mothers giving birth in clinics and private nursing homes have, as expected, the highest mean age at birth, lowest cumulative fertility, and lowest probability of reporting at least one child death. Although the controls for age, city, and hospital type can be regarded as useful in the present analysis, the observed patterns of coefficients for these factors underscore the need for more detailed information on socioeconomic position and behaviors relating to fertility and child health. They also serve to caution against over-interpretation of the consanguinity differentials that are the focus of this analysis.

The overall picture of younger maternal age at first livebirth in consanguineous marriages, with greater resultant fertility but higher rates of postnatal mortality including multiple family deaths, is in line with observations from other studies (*21*). The results can neither confirm nor refute the hypothesis (*48*) that, in South Indian communities, the practice of consanguineous marriage over multiple (70 to 80) generations would have led to significant removal of deleterious recessive alleles from the gene pool. As yet, proponents of this hypothesis have failed to provide evidence in support of the many underlying sociodemographic implications. These include the unbroken social acceptability of uncle-niece and first cousin marriages throughout the envisaged time span, whether in each and every generation there would indeed have been a suitable close relative to marry, and the possibilities of adoption and nonpaternity (*45*). The high gross and net fertility of consanguineous couples also would make rapid elimination of deleterious recessives improbable and, in this malarial region, a variety of disease-associated mutations may be maintained by heterozygote advantage.

Future Prospects

Considered on a global basis, it is apparent that consanguineous marriage is the preferred or prescribed choice for a significant proportion of the world's large population groups, particularly in Asia and Africa. With industrialization, greater population movement, a decline in family size and higher literacy rates, some reduction in the frequency of certain types of consanguineous marriage seems inevitable; for example, among uncle-niece unions in South India. But these changes will be slow, especially in rural areas where the vast majority of the people live. In addition, the adoption of fundamentalist doctrines throughout the Islamic world is provoking a return to more traditional practices, which may well lead to increased rates of marriage to a close relative. On balance, with the current high rates of population growth in Asian and African countries, a global increase in the numbers of consanguineous progeny appears probable for the immediate future, at least when measured in absolute terms. This forecast is not restricted to the less developed nations. It also holds true in many more developed countries in Western Europe, North America, and Oceania, which have experienced sizable Asian and African migration during the last four decades. Preliminary studies conducted among immigrant populations indicate their continuing and even increased practice of marriage to a close relative, and significantly greater fertility than the indigenous populations (*49*).

As socioeconomic conditions improve and the incidence of primarily environmental infectious and nutritional diseases concomitantly declines, genetic disorders will account for an ever-increasing proportion of global childhood morbidity, a pattern already widely observed in more developed, low mortality countries (*50*). The faster the transition of a population from less to more developed status the more rapidly this change in disease profile will occur, and populations that practice consanguinity may be disproportionately affected. This could explain why, by the 1980s, recessive genetic disorders had attained proportionately higher frequency in the population of Kuwait (*51*) and have become obvious in first generation migrants from developing to developed countries, an example being the large Pakistani community resident in the United Kingdom (*52*). While access to better and more sophisticated health care facilities should lead to increased survivorship of progeny with recessive gene disorders, in practice it additionally may result in increased health costs because of more frequent and longer periods as hospital inpatients (*53*).

The findings of the South Indian study emphasize that, typically, the excess mortality associated with consanguinity is restricted to a minority of families. If the particular health needs of such families are to be met, preferably organized in conjunction with community-based counseling programs, our knowledge of all aspects of consanguinity must be improved. From a genetic viewpoint, this would include assessment of the extent to which the marriage partners in preferentially inbred unions are heterozygous for more than one deleterious recessive gene (*54*) and the derivation of empirical risk rates for complex gene disorders. However, the social, cultural and economic benefits of consanguineous unions also need to be fully considered. Given the near global extent of consanguineous marriage, and the large proportion of the world's population directly involved, this is an issue that requires resolution in many less developed nations and developed, multi-ethnic societies alike.

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