

Interplay of Socio-economic Factors, Consanguinity, Fertility, and Offspring Mortality in Monastir, Tunisia

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Aim To assess the association among social status, prevalence of consanguineous marriages, and the effects of consanguinity on reproductive behavior and mortality in Tunisia.

Methods The study included data on a total of 1741 live-births born from November 1989 to October 1990 in the maternity ward of the University-Hospital Fattouma Bourguiba of Monastir, Tunisia. After delivery, women filled out a questionnaire on the age of the parents at marriage, the number of pregnancies and abortions, the number of neonatal and post-neonatal deaths, and deaths of children under 5 years. Three categories of marriages were distinguished as follows: marriages between first cousins, marriages between cousins of other degree, and non consanguineous marriages.

Results Consanguineous marriages represented 432 (24.81%) of the unions. Most consanguineous marriages were contracted between first cousins (n = 303; 70.13%). Consanguineous couples had a lower age at marriage and a higher fertility index than non-consanguineous couples. The rates of spontaneous abortions and stillbirths were not correlated with consanguinity. However, higher rates of neonatal and post-neonatal deaths, and deaths of children younger than 5 years were observed in consanguineous couples.

Conclusion Fertility index and mortality, especially in the first year of life, were significantly higher in consanguineous marriages. This important socio-economical factor needs to be considered in assessing equity on health in specific social and cultural contexts.

Consanguineous marriages are defined as the unions of individuals with at least one common ancestor. They are especially frequent in North Africa and most of west, central, and south Asia, where 20 to 50% of all marriages are consanguineous (1). Many studies demonstrated that consanguineous marriages were deeply rooted in Arab and Muslim populations (1-5), with more than 50% consanguineous unions in many Muslim countries (2-5). The highest consanguinity rates were reported among Pakistan army personnel and isolated Egyptian Nubians (76% and 80.4%, respectively) (6,7).

In general, consanguinity is influenced by geographic, demographic, religious, cultural, and socio-economic factors (1,8,9). The highest rates of consanguineous unions were associated with low socio-economic status, low education, and living in rural areas (2,4,10-13).

This kind of union increases the frequency of homozygous genotypes in populations. This may increase the expression of deleterious alleles and recessive diseases in the progeny of related spouses. Many reports on the health effects of consanguinity have shown its impact on reproduction, infant mortality, and rare Mendelian disorders (1). For example, an increase in morbidity and mortality was found in the descendents of closely related spouses, especially first-degree cousins (14-18). In addition, consanguinity has been associated with congenital anomalies (19-23) and several other disorders such as kidney diseases (24), blood diseases (25), deafness (26,27), breast cancer (28), and many genetically complex late onset diseases (29-34).

Tunisia is one of the Muslim countries in North Africa with a high rate of consanguinity. Mean coefficient of inbreeding is $8.76 \cdot 10^{-3}$ in the Northwest regions and $21.34 \cdot 10^{-3}$ in the central regions of the country (35).

In a previous study, we have established a link between socio-economic factors and

the prevalence of consanguineous marriages in Tunisia and Croatia (36). The aim of this study was to determine the interplay between social status, prevalence of consanguineous marriages, and the effects of consanguinity on reproductive behavior and mortality in Tunisia. The aim of this study was to determine the prevalence of consanguinity in the Tunisian region of Monastir and to evaluate its impact on the fertility and progeny of consanguineous couples.

Population and methods

The study was conducted in the region of Monastir, situated in the Central East of Tunisia. The study included all the live-births, born from November 1989 to October 1990 in the maternity ward of the University-Hospital Fattouma Bourguiba of Monastir.

After delivery the women filled out the questionnaire which included her age and that of her husband at marriage, as well as the history of her reproductive behavior before the present delivery, such as the number of pregnancies, live-births, spontaneous abortions, neonatal (1-27 days) and post-neonatal deaths (28-364 days), and deaths of children younger than 5 years. The degree of consanguinity between husbands and wives was also investigated.

Women who delivered for the first time and had no history of pregnancy were excluded from this analysis. Fertility was measured by the number of pregnancies per woman. Pregnancies included full term births, premature live births, and reproductive wastage (ie, stillbirths and abortions).

Unions between second cousins or closer relatives were categorized as consanguineous. Three categories of marriages were recorded as follows: marriages between first cousins, marriages between other degrees of cousins, and non consanguineous marriages.

Statistical analysis

The relationship between consanguinity and mean maternal and paternal age at marriage, and number of pregnancies and live-births was examined using ANOVA with Tukey post-hoc test.

The association between consanguinity and mortality by age interval was examined for each consanguinity class using χ^2 test. The *P* values were calculated and significance was set at 0.05. Statistical analysis was conducted using Statistical Package for the Social Sciences, version 10.0 (SPSS Inc., Chicago, IL, USA) and EpiInfo, version 6.04 (Centers for Disease Control and Prevention, Atlanta, GA, USA).

Results

Among 1741 consecutive live-births, 24.81% were the offspring of consanguineous parents (Table 1). Marriages between first cousins comprised 17.40% of all unions and 70.13% of all consanguineous marriages.

The difference in mean age at marriage of wives and husbands in the 3 groups was significant when we compared it by ANOVA test (Table 1). However, when we performed comparisons between each two groups with Tukey post-hoc test, we found a non-significant dif-

ference. Mean age at marriage of wives and husbands in unions between first cousins and between cousins of other degrees was lower than that in non-consanguineous unions.

The mean number of pregnancies per woman was significantly higher in related couples than in non related couples (Table 2). This relationship persisted for live-births, although the difference was reduced because of greater antenatal losses in consanguineous unions.

The rates of spontaneous abortions and stillbirths were not associated with consanguinity, but there was a positive correlation between consanguinity and neonatal and post-neonatal deaths, and deaths of children younger than 5 years. Mortality increased with the degree of inbreeding; the rate of neonatal and post-neonatal deaths, and deaths of chil-

Table 3. Rates of abortions, stillbirths, and mortality of neonates, infants, and children under 5 years according to different consanguinity types

Pregnancy outcome	Type of consanguinity			<i>P</i> [§]
	first cousins (n = 303)	other degree cousins (n = 129)	no consanguinity (n = 1309)	
Abortions*	73.88	71.09	79.64	–
Stillbirths†	16.83	16.67	15.48	–
0-27 d‡	39.12	29.06	20.54	<0.008 [§]
28-364 d‡	34.23	33.90	19.58	<0.017 [§]
0-364 d‡	73.35	62.95	40.12	<0.000 [§]
1-5 y‡	18.34	12.11	6.42	<0.005 [§]

*Abortion is expressed per 1000 pregnancies.
 †Stillbirth is expressed per 1000 births.
 ‡Neonatal (0-27 d), postneonatal (28-364 d), and child (1-5 y) deaths are expressed per 1000 live-births.
 § χ^2 test.

Table 1. Distribution of different consanguinity categories and parental ages at marriage (mean and standard error) according to different consanguinity classes

Parameters	Type of consanguinity			<i>P</i> [*]
	first cousins	other degree cousins	no consanguinity	
Number (%) of marriages and percentage	303 (17.40)	129 (7.41)	1309 (75.19)	–
Maternal age (mean±standard error)	21.66 ± 0.19	21.40 ± 0.30	22.15 ± 0.10	0.016
Paternal age (mean ± standard error)	25.99 ± 0.25	26.07 ± 0.46	26.72 ± 0.15	0.043

*ANOVA. Tukey post hoc showed no significant differences. The difference between ANOVA and Tukey post-hoc tests occurred because of slightly different procedures used in the two tests and because of the conservative nature of the Tukey test.

Table 2. Total pregnancies and livebirths per mother according to different consanguinity classes

Parameters	Mean number per mother ± standard error according to type of consanguinity		
	first cousins (n = 303)	other degree cousins (n = 129)	no consanguinity (n = 1309)
Pregnancies	4.33 ± 0.13	4.91 ± 0.20*	4.03 ± 0.056
Live-births	3.45 ± 0.091	3.96 ± 0.15†	3.26 ± 0.045

*Significant difference from non consanguinity group (*P*<0.001) and first cousins (*P*=0.024; ANOVA with Tukey post hoc).
 †Significant difference from non consanguinity group (*P*<0.001) and first cousins (*P*=0.008; ANOVA with Tukey post hoc).

dren younger than 5 years was 39.12 %, 34.23 %, and 18.34 %, respectively, in first cousins, in comparison with 20.54 %, 23.69 %, and 6.42 %, respectively, in non-consanguineous couples (Table 3).

Discussion

The study confirmed that, similar as in other Arab and Muslims communities, in Tunisia there was a high proportion of consanguineous unions (24.81%). This is lower than rates reported in Asia and Africa, such as 58.7% in Karachi (Pakistan) (37); 54% in the state of Qatar (2); 52% in Saudi Arabia (38); 50.5% in the United Arab Emirates (39); 44.7% in Sana'a (Yemen) (5); 42.1% in Kuwait (40); 34% in Tlemcen (west Algeria) (4); 33.9% in the province of Antalya (Turkey) (13); 33% in the Sultanate of Oman (3); 25.6% in Jordan (41); and 25% in Lebanon (14).

Furthermore, in our study the rate of first cousins unions was 70.13% among all marriages between relatives. Demographic data concerning Arab and Muslim communities, in North Africa, most of west, central, and south Asia, showed the high prevalence of first cousins' unions among consanguineous marriages (2,3,5,14,36-41).

As expected, our study showed that, due to an earlier age at marriage, the potential fertile period was significantly longer in consanguineous unions. We also noticed higher mean fertility index in consanguineous couples but lower mean number of live births in non-consanguineous group. Tunisia is a country that has undergone a considerable reduction in fertility; in the period 1950-1955 there were 6.93 children per woman while in the period 1995-2000 this number was 2.31. Tunisia experienced an average decline in the total fertility of 1.06 children per decade (42). This rapid transition resulted in the change of some cultural, environmental, and socio-economic

factors. Studies on the effects of consanguinity on fertility have led to divergent results (1,14,43-45). It remains difficult to explain the causality attributed to consanguinity. In general, factors positively associated with consanguinity were fertility and family size. These may be a compensation for increased mortality of children in consanguineous marriages (2,15,46). However, consanguineous unions have prevailed over time for socio-economic and cultural reasons (1,8,9). This may have been an important contributory factor for such couples, in particular for women, to marry and have first birth at earlier age. Early marriages are important for increased fertility since they increase the maternal reproductive span and the childbearing takes place in the most fertile years (15). More recent studies reported that a number of direct and indirect fertility determinants were associated with consanguinity, including lower socioeconomic status, religious convictions, lower maternal age at marriage, lower contraceptive practice use, duration of marriage, and rural residence (14,43-45). In the absence of the adequate control of these parameters, the results must be treated with caution.

Our data did not show any notable difference in abortions and stillbirths between consanguineous and non-consanguineous parents. However, the number of spontaneous abortions may have been greater, since possible abortions that had taken place in the first 3 weeks of pregnancy and had not been detected by women were not included in this number. The same results were reported in other populations, such as in Beirut, Lebanon, indicating that the natural selection after inbreeding may not operate at prenatal life period (14). Indeed, Khoury et al (47) reported that the excessive mortality of progeny of first cousins can be seen for all periods of pre-reproductive life, but to a less extent for miscarriages and stillbirths.

Higher neonatal, post-neonatal, and children mortality rates were observed in the offspring of consanguineous spouses mainly in the progeny of first cousins, suggesting that the increased expression of recessive deleterious alleles was significantly correlated with higher mortality. This finding was in accord with the results of previous studies conducted in different populations (1,10,13-16,43,46). Socio-economic and demographic factors must be taken into account when analyzing the mortality data. Several studies reported socio-economic differences between consanguineous and non-consanguineous families. Consanguineous unions were more prevalent among poor and less educated families (1), while low paternal education and occupation levels were positively associated with consanguinity (10,11). Low socio-economic status and low education may interact with consanguinity and have an effect on the health care, in particular on the rates of infant mortality. Maternal illiteracy was reported to be associated to higher offspring mortality in developing countries (17). Khlaf (14) showed that, at the multivariate level, status of marriage is not associated with child mortality, whereas professional status of the father remains a significant factor. Other studies of infant death in Abu Dhabi and Norway confirmed that maternal lack of formal education and low monthly income were significantly associated with child death (48,49).

This study had several potential limitations. First, the sample is not representative of the general population, as most of women that gave birth at the maternity ward of the University-Hospital Fattouma Bourguiba of Monastir were from the town of Monastir and its surroundings. Second, since this was an university hospital, many women were transferred there from other hospitals in the region because they had problems in the present or previous deliveries, which could have

increased the rate of women who experienced abortions or child death.

In conclusion, the prevalence of consanguineous marriages found in this study is important. Consanguineous unions tend to occur at earlier age. Fertility is more elevated among the women in consanguineous marriages than in women in non-consanguineous marriages. Mortality, especially in the first month of life, was positively associated with consanguinity. However, factors such as the socio-economic status of parents, pregnancy intervals, contraceptives use, and area of residence also have to be taken into consideration (50). Fertility index and mortality, especially in the first year of life, were significantly increased with consanguinity, which is linked to socio-economic status (36), which makes this an example of indirect effects of inequity on health in a specific context.

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