**ORIGINAL RESEARCH ARTICLE**

# Correlates and reproductive consequences of consanguinity in six Egyptian governorates

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## Abstract

This study aimed to explore some correlates and potential reproductive consequences of consanguinity. We analysed data for 8515 ever-married women aged 15-49 derived from a household survey conducted in 2017 in six governorates. The prevalence of consanguineous marriage was 35.9%. The odds (OR (95%CI)) of consanguinity were higher in rural southern governorates (3.68 (3.03-4.46)), with less than secondary education (1.55 (1.42-1.7)), with unemployment (1.74(1.48-2.04)) and in the lowest wealth quintile (3.09 (2.66-3.6)). After adjusting for residence, education, wealth, age at marriage and the number of children; the OR (95%CI) for spontaneous abortion and still births with consanguinity were 1.31 (1.09-1.59) and 1.63 (1.18-2.25) respectively. Consanguinity remains highly prevalent in Egypt especially in rural southern governorates. Women empowerment in terms of attaining higher education and employment may reduce the problem. Consanguinity appears to be associated with adverse reproductive outcomes including spontaneous abortion and still birth. *(Afr J Reprod Health 2022; 26[12s]: 48-56).*

**Keywords:** Consanguinity, spontaneous abortion, still birth, infant mortality, Egypt

## Résumé

Cette étude visait à explorer certains corrélats et les conséquences reproductives potentielles de la consanguinité. Nous avons analysé les données de 8515 femmes célibataires âgées de 15 à 49 ans tirées d'une enquête auprès des ménages menée en 2017 dans six gouvernorats. La prévalence du mariage consanguin était de 35,9 %. Les probabilités (OR (IC à 95 %)) de consanguinité étaient plus élevées dans les gouvernorats ruraux du sud (3,68 (3,03-4,46)), avec une éducation inférieure à l'enseignement secondaire (1,55 (1,42-1,7)), avec le chômage (1,74 (1,48-2,04) ) et dans le quintile de richesse le plus bas (3,09 (2,66-3,6)). Après ajustement sur la résidence, l'éducation, la richesse, l'âge au mariage et le nombre d'enfants ; l'OR (95 % IC) pour l'avortement spontané et les mort-nés avec consanguinité étaient de 1,31 (1,09-1,59) et 1,63 (1,18-2,25) respectivement. La consanguinité reste très répandue en Égypte, en particulier dans les gouvernorats ruraux du sud. L'autonomisation des femmes en termes d'accès à l'enseignement supérieur et d'emploi peut réduire le problème. La consanguinité semble être associée à des effets indésirables sur la reproduction, notamment l'avortement spontané et la mortinaissance. *(Afr J Reprod Health 2022; 26[12s]: 48-56).*

**Mots-clés**: Consanguinité, avortement spontané, mortinaissance, mortalité infantile, Egypte

# Introduction

Consanguineous marriage is described as a union between biological relatives who share at least one common ancestor. In clinical genetics, a consanguineous marriage commonly refers to a union between individuals related as second cousins or closer[1-4].

Consanguineous marriage is an ancient practice[5]. Even in recent times, it was estimated that over one billion people live in societies where consanguineous marriages are common[6]. Almost 10% of marriages worldwide occur between biological relatives[7,8]. Consanguinity rates vary around the world. Approximately 1% of marriages are consanguineous in Europe and North America.

The highest prevalence of consanguineous marriage has been recorded in North Africa, the Middle East and Central and Southern Asia, ranging between 20% and more than 50%. First-cousin unions are the most

common[5,9-13]. According to Egypt demographic health survey (EDHS 2014), 31% of married women in Egypt were in consanguineous marriages[14]. The trend of consanguineous marriage seems to be stable or even increasing among newer generations especially in Arab countries[5,13].

Studies have consistently found a higher proportion of consanguineous marriage in rural areas[5,12,15]. Traditionally, higher rate of consanguineous marriages are found in rural areas in Egypt, especially in rural Upper (southern) Egypt where nearly half of marriages occur between blood relatives[14].

Social and economic considerations often come to play in the preference for consanguineous marriage. It is traditionally believed that consanguinity strengthens family ties, reduces chances of divorce and domestic violence, preserves wealth (e.g., land heritage) within the family and reduces the financial costs of marriage[1,10,12,16]. Several studies in Egypt and in other countries found that women with lower education levels, women who do not work for cash and women in the lower wealth quintiles were more likely to be married to a relative[9,10,14,17].

It is widely accepted that consanguineous marriage is associated with deleterious autosomal recessive conditions[4,18-22]. Studies across various settings suggest that the incidence of any congenital anomaly is typically 2 to 3 per 100 births among unrelated couples compared with 5 to 6 per 100 births among first cousin couples[7,23,24]. Congenital anomalies and hereditary diseases most associated with consanguinity include congenital heart defects such as ventricular or atrial septal defects, neural tube defects, congenital deafness, inborn errors of metabolism, severe muscular dystrophy, familial Mediterranean fever, sickle cell anaemia and thalassaemia[4,9,25,26].

Several studies in Asia and studies on immigrant Pakistanis in Europe have examined the impact of consanguineous marriages on perinatal, neonatal, and infant mortality. Consanguineous parents were found to be at twofold greater risk of having a reproductive loss in the perinatal and neonatal period than unrelated parents. Infant mortality (from birth until one year of age) was also 2-3 folds higher among first cousins compared to unrelated couples[4,15,27,28]. An analysis of Demographic health survey data of Egypt for the year 2000, reported a respective 30% and 50% higher odds of infant and child mortality among close consanguineous couples[29].

Reviews of early studies on the impacts of consanguineous marriage reported contradictory results on foetal losses and stillbirths, with several studies indicating no effect of consanguinity. Limitations related to small sample sizes, inaccurate definition of abortion, data quality issues and the lack of control over potential confounders have characterized most of these early studies[4,5,16]. More recently, a meta-analysis of 46 studies has estimated an excess mean stillbirth rate of 0.7% among first cousins[4]. A case control study in Iran concluded that consanguineous marriage was associated with increased risk of stillbirth, particularly preterm stillbirth after adjusting for confounders as maternal age, body mass index, parity and history of obstetric complications[30]. A recent survey in a Pakistani hospital found significantly higher proportions of still births and abortions among women in consanguineous marriages[10]. A survey among 4418 women aged 15-49 years in Palestinians territories reported 30% increased risk of reproductive losses (combining abortion and still births) among consanguineous couples[31].

Consanguineous marriage is also commonly associated with younger female age at marriage and a higher mean number of live births[4,9,15-17,26,32]. A study in Oman also reported that consanguineous marriage was associated with a lower rate of contraceptive use [32]. The higher fertility among consanguineous couples can increase the probability of having children with genetic disorders. On the other hand, the greater mean number of births to consanguineous couples may reflect reproductive compensation for child deaths, which might in turn contribute to the persistence of recessive alleles in the population[4,16].

Our study aimed to explore some correlates and potential reproductive consequences of consanguineous marriages (including spontaneous abortion/miscarriage, still births, infant and child death) among Egyptian women between 15-49 years of age in three northern and three southern governorates.

# Methods

## *Study design and study setting*

The current study is a secondary analysis of data collected in a large household survey entitled "Surveillance of socio-demographic and health indicators in some Egyptian governorates" implemented between May and September 2017. The

original survey was conducted in six purposefully selected Egyptian governorates: three from Upper "Southern" Egypt (Sohag, Assiut, and Menia) and three from Lower "Northern" Egypt (Sharkia, Behira, and Ismailia). The six governorates had the least favourable demographic and health indicators in Egypt based on monitoring and evaluation reports of the National Population Council (NPC) in Egypt.

### *Sample size*

The sample size was calculated for the original survey using the prevalence indicator nearest to 50% (which was the use of family planning methods) yielding the largest sample size, taking into consideration the population size in each governorate. The total sample size was 2500 in Sharkia, 600 for Ismailia and 2000 each from Beheira, Minya, Assiut, and Sohag. We used a 95% confidence level, 2% margin of error and a design effect of 2.0.

### *Sampling method*

The sample frame for that survey was derived from Egyptian census for the year 2006, provided by the Central Agency for Public Mobilization and Statistics (CAPMAS). The sample was in the form of 100–125 randomly selected clusters per governorate. Each cluster included 20 family households, identified by the name of the head of the household and geographical (rural and urban) and administrative divisions including centres, departments, villages, and districts. A household (sampling unit) was defined as two persons or more living in one house and economically sharing a single comprehensive dwelling. All age groups and genders were included.

The eligible participants for the current analysis were ever-married women (including currently married, divorced, separated, and widowed women) aged 15–49 years old for whom complete data were available. A total of 8515 were included (Sharkia:1825, Behira:1704, Ismalia:529, Sohag:1477, Assuit:1475 and Menia:1505).

### *Data collection tool*

A structured questionnaire was used to collect data through in-person interviews. Data was collected by nurses and rural female community health workers known as "Raedat Refeyat".

The questionnaire was composed of two sections:

- The first section included: Socio-demographic data (age, residence, education, employment, marital status, consanguinity, and age at marriage). Data on household characteristics and assets were collected to calculate a wealth index which was later divided into wealth quintiles.
- The second section included: medical history (including history of chronic diseases and obstetric history (specifically: live births, spontaneous abortion/miscarriage, still birth, neonatal mortality (i.e., death during the first month of life), post neonatal mortality (i.e., death after the first month till the end of the first year of life), child mortality below five years of age, and child mortality 5 to 18 years of age. History of antenatal care during the last pregnancy within the past 3 years and the use of contraceptive methods were also obtained.

This analysis focused on socio-demographic determinants of consanguineous marriages as well as reproductive consequences indicated in the obstetric history. We also compared contraceptive use by consanguinity status.

### *Statistical analysis*

Statistical analysis was performed using SPSS version 24. Quantitative variables were summarized in the forms of mean± standard deviations or median and interquartile range (IQR). Categorical variables were presented in frequencies and percentages. Bar charts were used for graphical presentation of categorical data. Comparison of binary and multinomial categorical variables were done using Chi square test. Linear by linear association p values were taken for ordinal categorical variables. Means were compared between two groups using independent samples t test. Mann Whitney U test was used to compare medians between two groups. Odds Ratio (OR) and 95% Confidence Interval (95% CI) were calculated. Propensity score for consanguinity was calculated to adjust for residence, education, wealth, early marriage, and number of live children. Binary logistic regression function within generalized estimating equations, was used to calculate adjusted ORs for the association between consanguinity and reproductive outcomes applying inverse propensity score weighing. Statistical significance was considered at p value $\leq 0.05$.

## Results

A total of 8515 ever-married women aged 15-49 years were included in this analysis. Overall, 3058 (35.91%; 95%CI= 34.90%-36.94%) reported that their current or most recent marriage was to a blood relative. We examined socio-demographic factors that were likely associated with consanguineous marriage (Table 1).

**Table 1:** Sociodemographic characters associated with consanguineous marriage among ever married women in Six governorates in Egypt (N=8515)

| Sociodemographic Characters | | Total | Consanguineous marriages | | OR (95%CI) |
|---|---|---|---|---|---|
| | | | Number | Percent | |
| Region & Residence | Upper Egypt: Rural | 3559 | 1700 | 47.77 | 3.68 (3.03-4.46)* |
| | Upper Egypt: Urban | 898 | 292 | 32.52 | 1.94 (1.54-2.44)* |
| | Lower Egypt: Rural | 3325 | 920 | 27.67 | 1.54 (1.26-1.87)* |
| | Lower Egypt: Urban [a] | 733 | 146 | 19.92 | 1 |
| Education | Less than secondary | 4848 | 1949 | 40.20 | 1.55 (1.42-1.7)* |
| | Secondary or higher [a] | 3667 | 1109 | 30.24 | 1 |
| Work status | Not working | 7647 | 2838 | 37.11 | 1.74 (1.48-2.04)* |
| | Working for cash [a] | 868 | 220 | 25.35 | 1 |
| Wealth quintiles | Lowest | 1578 | 750 | 47.53 | 3.09 (2.66-3.6)* |
| | Second | 1680 | 725 | 43.15 | 2.59 (2.23-3.01)* |
| | Middle | 1731 | 658 | 38.01 | 2.09 (1.8-2.43)* |
| | Fourth | 1889 | 554 | 29.33 | 1.42 (1.22-1.65)* |
| | Highest [a] | 1637 | 371 | 22.66 | 1 |

*CI: Confidence Interval, OR: Odds Ratio*
**Statistically significant difference, P ≤ 0.05*
*[a] Reference category*

**Table 2:** Association between consanguinity and the reproductive outcomes among ever married women in Six governorates in Egypt

| Outcome | | Number | Percent | Crude OR (95%CI) | Adjusted OR [b] (95%CI) |
|---|---|---|---|---|---|
| Spontaneous abortion/ miscarriage | Consanguineous | 231 | 7.55 | 1.57 (1.31-1.88)* | 1.31 (1.09-1.59)* |
| | Non-consanguineous [a] | 270 | 4.95 | 1 | 1 |
| Still birth | Consanguineous | 88 | 2.88 | 2.22 (1.62-3.04)* | 1.63 (1.18-2.25)* |
| | Non-consanguineous [a] | 72 | 1.32 | 1 | 1 |
| Neonatal Mortality | Consanguineous | 93 | 3.04 | 0.97 (0.75-1.25) | 0.78 (0.6-1.02) |
| | Non-consanguineous [a] | 171 | 3.13 | 1 | 1 |
| Post neonatal Mortality | Consanguineous | 24 | 0.78 | 1.34 (0.79-2.28) | 1.09 (0.63-1.88) |
| | Non-consanguineous [a] | 32 | 0.59 | 1 | 1 |
| Child Mortality < 5 years | Consanguineous | 20 | 0.65 | 1.38 (0.77-2.47) | 1.07 (0.58-1.95) |
| | Non-consanguineous [a] | 26 | 0.48 | 1 | 1 |
| Child Mortality > 5 years | Consanguineous | 21 | 0.69 | 2.69 (1.37-5.29)* | 2.39 (1.19-4.83)* |
| | Non-consanguineous [a] | 14 | 0.26 | 1 | 1 |

*Total number =8515 women; 3058 in consanguineous marriage and 5457 in non-consanguineous marriage*
*CI: Confidence Interval, OR: Odds Ratio*
**Statistically significant P ≤ 0.05*
*[a] Reference category*
*[b] Binary logistic regression in Generalized estimating equations with inverse propensity score weighting was used. OR was adjusted for region and residence, education, age at marriage <18, number of children and wealth.*

We found that consanguineous marriage prevalence was highest in rural Upper Egypt. In urban areas, nearly one fifth of women in Lower Egypt and one third of women in Upper Egypt were married to a blood relative. The odds ratio of marrying a blood relative was 55% higher among women with less than secondary education compared to women with secondary or higher education. Consanguinity was more common among women who were not working for cash. The proportion of women marrying blood relatives decreased with increasing wealth quintile, from 47.5% among women in the lowest wealth quintile to 22.7% of women in the highest quintile.

In Figure 1, the percentage of consanguineous marriages were described across age groups in the different regions. The youngest age group (15-19 years) was excluded due to the very small numbers of women in this category. The proportion of consanguineous marriage didn't differ significantly across age groups in urban areas neither in Upper nor in Lower Egypt. In rural Lower Egypt, the proportion of consanguineous marriage declined slightly in younger age groups (p=0.025). In rural

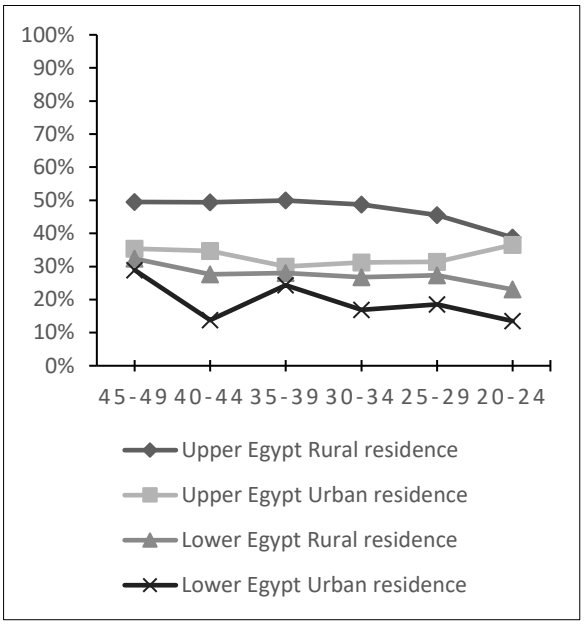


**Figure 1:** The percentage of consanguineous marriages across age groups by region (Upper/Lower Egypt) and rural/urban residence

Upper Egypt, the proportion of consanguineous marriage among women in the 20-24 age group differed significantly from that in older groups (p=0.004).

We examined the association between consanguinity and age at first marriage and the number of children a woman had (Figure 2). The mean age at marriage for women in consanguineous marriages (18.93±3.16 years) was one year less than the mean age for women in non-consanguineous marriages (19.77±3.58 years). The difference was statically significant with p<0.001. Figure (2a) shows the mean age at marriage for women in consanguineous and non-consanguineous marriage in all regions. Generally, the mean number of children a woman had was 3.49±1.58 among women in consanguineous marriages compared to 3.12±1.43 for women in non-consanguineous marriages (p<0.001). Figure (2b) shows the mean number of children for women in consanguineous and non-consanguineous marriage in all regions.

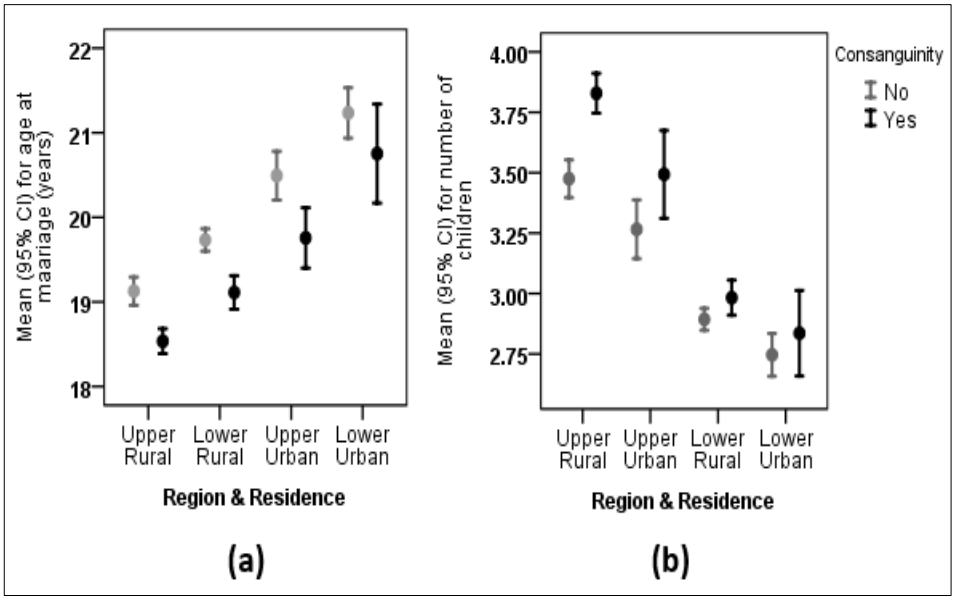


**Figure 2a:** Error bars comparing mean (95%CI) age at marriage by consanguinity status across regions and residence, b): Error bars comparing mean (95%CI) number of children by consanguinity status across regions and residence

Data on contraception use were available for 4013 women. The overall proportion of ever use of contraceptive methods among women in consanguineous marriages was a little less than that in women in non-consanguineous unions: 78.73% versus 81.96% respectively (p =0.015). However, when stratified by region and residence (Figure 3), no significant association was observed between consanguinity and contraceptive use.

Similarly, no significant association was observed between consanguinity and the duration of contraceptive use. Median (IQR) months of contraceptive use were 30(12-60) vs 29 (12-60) in Upper Egypt (p=0.960). Median (IQR) months of

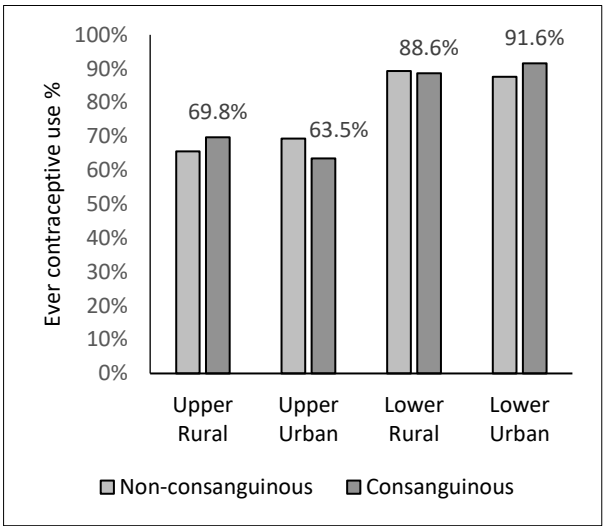


**Figure 3:** Comparing the Proportion of women who have ever used contraceptives by the status of consanguinity stratified by region: Upper and Lower Egypt; and by the type of residence: Urban and Rural

contraceptive use were 96 (46-146) vs 90(48-144) in Lower Egypt (p=0.608).

Women were asked about the history of six reproductive outcomes including: spontaneous abortion/miscarriage, still births, infant mortality in neonatal and postnatal periods, child mortality below 5 years and above 5 years of age. The association between consanguinity and these outcomes are shown in Table 2. The proportion of spontaneous abortion/miscarriage was 2.5% higher among women in consanguineous marriages.

The association remained statistically significant after adjusting for other factors as residence, education, wealth, early age of marriage (<18) and the number of children. Univariate analysis showed that the proportion of still birth among women in consanguineous unions was double that among women in non-consanguineous unions. The association remained significant after adjusting for other factors. We found no statistically significant association between consanguineous marriage and neonatalv mortality, potsv neonatal mortality or mortality below 5 years. Child mortality after 5 years was more frequently recalled by women in consanguineous marriages and the difference was statistically significant (Table 2).

## Discussion

Our study shows that Egypt has a high prevalence of consanguinity, similar to other Arab countries in the middle East where the practice is traditionally common[5,13]. The overall proportion of consanguineous marriages among ever-married women in this study was 35.91%, which is a little higher than the 31% reported in EDHS 2014[14]. However, it is important to stress that the current analysis involved women in only 6 governorates which were touted to have the least favourable health indicators in the country.

When comparing the proportion of consanguineous marriage across regions, we found them nearly identical to those reported in the EDHS 2014; being highest in rural Upper Egypt; where consanguineous marriage accounts for half of all marriages. The proportion of consanguineous marriage is generally higher in Upper Egypt than in Lower Egypt, especially in rural areas. This comes in agreement with Khayat and Saxena (2000), where consanguinity rates were higher in rural areas compared to urban areas (46.0% versus 27.3%) and in Upper Egypt compared to Lower Egypt (46.5% versus 31%)[29]. Socioeconomic factors such as strengthening family ties and preservation of wealth may explain the high prevalence of consanguinity in rural areas[1,10,12,16]. In our study, we observed a slow reduction in consanguineous marriages in the younger age groups in rural Lower Egypt. In rural Upper Egypt, a significant reduction in consanguineous marriages started to appear in the 20-24 age group, but only continued follow up will reveal if a new trend is forming.

Findings from the current study agreed with previous studies that reported higher chances of consanguineous marriage among women in the lower wealth quintiles, women with lower education level and among women not working for cash[9,10,17]. So, it is likely that empowering women in terms of education and employment may enhance the efforts aiming at reducing the practice of consanguineous marriage[5]. Like previous studies, we found that consanguineous marriage was significantly associated with younger age at marriage[4,17]. We also found that women in consanguineous marriages had a slightly higher mean number of children. It was implied previously that consanguineous couples tend not use contraceptives methods as non-consanguineous; which predisposes to having larger families[32]. In this regard, we compared the proportion and the duration of contraceptive use between women in consanguineous and non-consanguineous marriages

adjusting for regional variations and found no significant difference between the two groups. The higher mean number of children observed in consanguineous couples in our study may have resulted from the women's earlier age at marriage and the longer reproductive span. The higher fertility and higher numbers of live births among consanguineous couples were similarly reported in several Arab countries such as Saudi Arabia, Kuwait, Qatar and Tunisia[5]. Also, a meta-analysis of 40 studies reported that consanguineous couples had a higher mean number of live births that translated into 0.08 additional births per family on average[4].

In the current study, consanguineous marriage was associated with higher proportions of still births and spontaneous abortions/miscarriages. This agrees with the findings of another Egyptian study conducted on 730 couples in Alexandria which suggested that consanguinity plays a major role in the high rates of pre-natal and infant mortality[33]. Recent studies in Pakistan and Iran have reported similar findings[10,30]. In our study, the association between consanguinity and still birth and spontaneous abortion/miscarriage remained significant after adjusting for socioeconomic factors (including residence, education, and wealth quintile) and reproductive factors (including early age at marriage and the number of children). Contrary to several previous studies, we did not find a significant increase in neonatal or post neonatal mortality or deaths below 5 years of age. However, the proportion of child mortality after 5 years was doubled with consanguinity. This might reflect delayed deaths resulting from hereditary diseases. Improved healthcare for infants born with congenital defects may have played a role in delaying deaths till later childhood.

Further studies are needed to investigate this assumption since the causes of child deaths were not collected in our study.

## Limitations

There were a few limitations to the current study. First, this was a cross sectional survey with inherent limitations in establishing causal association. Recall bias cannot be ruled out since the data on reproductive outcomes were based on participants recall. Also, causes of child mortality were not collected.

## Ethics approval and consent to participate

The survey was approved by the Ethical Committee of the Faculty of Medicine at Ain Shams University in 2017. Administrative approvals and technical support were provided by the NPC and CAPMAS. Written informed consent was obtained from all participants. Privacy and confidentiality were maintained according to the revised declaration of Helsinki on Biomedical Research Ethics.

## Conclusion

Consanguineous marriage is still highly prevalent in Egypt especially in rural southern governorates. As women attain access to higher levels of education and employment, the prevalence of consanguinity may start to fall. Consanguineous marriage appears to be associated with adverse reproductive outcomes as spontaneous abortion/miscarriage and still birth. However, further longitudinal studies are needed to elucidate the impact of consanguinity on reproductive outcomes where variables such as medical and family history, maternal age at conception, birth order and birth intervals are adequately controlled.

## Contribution of authors

Wafaa M. Hussein has contributed to data analysis and interpretation, and drafted the manuscript. Maha M. El-Gaafary contributed to data analysis and interpretation, Ghada O. Wassif, Maha M. Wahdan, Dalia G. Sos, Sally A. Hakim, Amany M. Abdelhafez, Mohamed Y. El-Awady, Mervat H. Rady, Tarek T. Amin have contributed to conducting the survey and critically revised the manuscript. Wagida A. Anwar has contributed to the conception of the study and critical revision of the manuscript. All authors have approved the submitted manuscript.

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## References

1. Akrami SM. Genetics of consanguineous marriage: Impact and importance of counseling. *Journal of pediatric*

*genetics*. 2012/12//undefined 2012;1(4):217-220. doi:10.3233/PGE-12034
2. Darr A, Small N, Ahmad WIU, Atkin K, Corry P and Modell B. Addressing key issues in the consanguinity-related risk of autosomal recessive disorders in consanguineous communities: lessons from a qualitative study of British Pakistanis. *Journal of community genetics*. 2016/01//undefined 2016;7(1):65-79. doi:10.1007/s12687-015-0252-2
3. Bittles AH. Consanguinity, Genetic Drift, and Genetic Diseases in Populations with Reduced Numbers of Founders. In: Speicher MR, Motulsky AG, Antonarakis SE, eds. *Vogel and Motulsky's Human Genetics*. Springer Berlin Heidelberg; 2010:507-528.
4. Bittles AH, Black ML. The impact of consanguinity on neonatal and infant health. *Early human development*. 2010/11//undefined 2010;86(11):737-741. doi:10.1016/j.earlhumdev.2010.08.003
5. Tadmouri GO, Nair P, Obeid T, Al Ali MT, Al Khaja N and Hamamy HA. Consanguinity and reproductive health among Arabs. *Reproductive health*. 2009/10/08/ 2009;6:17. doi:10.1186/1742-4755-6-17
6. Modell B and Darr A. Science and society: genetic counselling and customary consanguineous marriage. *Nature reviews Genetics*. 2002/03//undefined 2002;3(3):225-229. doi:10.1038/nrg754
7. Bittles AH. *Consanguinity in Context*. Cambridge Studies in Biological and Evolutionary Anthropology. Cambridge University Press; 2012.
8. Bittles AH and Black ML. Consanguinity, human evolution, and complex diseases. *Proceedings of the National Academy of Sciences*. 2010/01/26/ 2010;107(suppl 1):1779. doi:10.1073/pnas.0906079106
9. Abbas HA and Yunis K. The effect of consanguinity on neonatal outcomes and health. *Human heredity*. 2014 2014;77(1-4):87-92. doi:10.1159/000362125
10. Abrar S, Safdar W, Hanif M and Shujaat N. Pregnancy Outcomes Of Consanguinity Among Antenatal Patients Attending Combined Military Hospital Quetta, Pakistan. *Journal of Ayub Medical College, Abbottabad : JAMC*. 2018/09//Jul- undefined 2018;30(3):423-427.
11. Islam MM, Dorvlo AS and Al-Qasmi AM. The pattern of female nuptiality in oman. *Sultan Qaboos University medical journal*. 2013/02//undefined 2013;13(1):32-42. doi:10.12816/0003193
12. Romdhane L, Ben Halim N, Rejeb I, Kefi R, Bouyacoub Y, Ben Rekaya M, Messai H, Messaoud O, Riahi Z, Bonnet C, Ben Rhouma F, Nagara M, Petit C, McElreavey K, Romeo G and Abdelhak S. Specific aspects of consanguinity: some examples from the Tunisian population. *Human heredity*. 2014 2014;77(1-4):167-174. doi:10.1159/000362167
13. Warsy AS, Al-Jaser MH, Albdass A, Al-Daihan S and Alanazi M. Is consanguinity prevalence decreasing in Saudis?: A study in two generations. *African health sciences*. 2014/06//undefined 2014;14(2):314-321. doi:10.4314/ahs.v14i2.5
14. Ministry of health and population[Egypt], El-Zanaty and associates[Egypt], ICF International. *Egypt Demographic and Health Survey 2014*. 2015.
15. Yunis K, Rafei RE and Mumtaz G. International Perspectives: Consanguinity: Perinatal Outcomes and Prevention – A View from the Middle East. *NeoReviews*. 2008/02/01/ 2008;9(2):e59-e65. doi:10.1542/neo.9-2-e59
16. Bittles AH. Consanguineous marriage and childhood health. *Developmental medicine and child neurology*. 2003/08//undefined 2003;45(8):571-576. doi:10.1017/s001216220300104x
17. Na'amnih W, Romano-Zelekha O, Kabaha A, Rubin LP, Bilenko N, Jaber L, Honovich M and Shohat T. Prevalence of consanguineous marriages and associated factors among Israeli Bedouins. *Journal of community genetics*. 2014/10// 2014;5(4):395-398. doi:10.1007/s12687-014-0188-y
18. Benson JWT. Recessive disorders and consanguineous marriage. *BMJ (Clinical research ed)*. 2005/12/17/ 2005;331(7530):1475-1475. doi:10.1136/bmj.331.7530.1475
19. Hamamy HA, Masri AT, Al-Hadidy AM and Ajlouni KM. Consanguinity and genetic disorders. Profile from Jordan. *Saudi medical journal*. 2007/07//undefined 2007;28(7):1015-1017.
20. Romeo G and Bittles AH. Consanguinity in the contemporary world. *Human heredity*. 2014 2014;77(1-4):6-9. doi:10.1159/000363352
21. Yunis K, Mumtaz G, Bitar F, Chamseddine F, Kassar M, Rashkidi J, Makhoul G and Tamim H. Consanguineous marriage and congenital heart defects: a case-control study in the neonatal period. *American journal of medical genetics Part A*. 2006/07/15/ 2006;140(14):1524-1530. doi:10.1002/ajmg.a.31309
22. Al-Gazali L and Ali BR. Mutations of a country: a mutation review of single gene disorders in the United Arab Emirates (UAE). *Human mutation*. 2010/05//undefined 2010;31(5):505-520. doi:10.1002/humu.21232
23. Corry PC. Consanguinity and prevalence patterns of inherited disease in the UK Pakistani community. *Human heredity*. 2014 2014;77(1-4):207-216. doi:10.1159/000362598
24. Sheridan E, Wright J, Small N, Corry PC, Oddie S, Whibley C, Petherick ES, Malik T, Pawson N, McKinney PA and Parslow RC. Risk factors for congenital anomaly in a multiethnic birth cohort: an analysis of the Born in Bradford study. *Lancet (London, England)*. 2013/10/19/ 2013;382(9901):1350-1359. doi:10.1016/S0140-6736(13)61132-0
25. Anwar WA, Khyatti M and Hemminki K. Consanguinity and genetic diseases in North Africa and immigrants to Europe. *European journal of public health*. 2014/08//undefined 2014;24 Suppl 1:57-63. doi:10.1093/eurpub/cku104
26. Oniya O, Neves K, Ahmed B and Konje JC. A review of the reproductive consequences of consanguinity. *European journal of obstetrics, gynecology, and reproductive biology*. 2019/01//undefined 2019;232:87-96. doi:10.1016/j.ejogrb.2018.10.042
27. Chaman R, Gholami Taramsari M, Khosravi A, Amiri M, Holakouie Naieni K and Yunesian M. Consanguinity

and neonatal death: a nested case-control study. *Journal of family & reproductive health*. 2014/12// 2014;8(4):189-193.
28. Kerkeni E, Monastiri K, Saket B, Guediche MN and Ben Cheikh H. Interplay of socio-economic factors, consanguinity, fertility, and offspring mortality in Monastir, Tunisia. *Croatian medical journal*. 2007/10//undefined 2007;48(5):701-707.
29. Khayat RG and Saxena PC. Consanguinity and its effect on fertility and infant and child mortality in Egypt. 2004:
30. Maghsoudlou S, Cnattingius S, Aarabi M, Montgomery SM, Semnani S, Stephansson O, Wikström AK and Bahmanyar S.. Consanguineous marriage, prepregnancy maternal characteristics and stillbirth risk: a population-based case–control study. *Acta Obstetricia et Gynecologica Scandinavica*. 2015/10/01/ 2015;94(10):1095-1101. doi:10.1111/aogs.12699
31. Assaf S, Khawaja M, DeJong J, Mahfoud Z and Yunis K. Consanguinity and reproductive wastage in the Palestinian Territories. *Paediatric and perinatal epidemiology*. 2009/03//undefined 2009;23(2):107-115. doi:10.1111/j.1365-3016.2008.00988.x
32. Islam MM. Effects of consanguineous marriage on reproductive behaviour, adverse pregnancy outcomes and offspring mortality in Oman. *Annals of human biology*. 2013/05//undefined 2013;40(3):243-255. doi:10.3109/03014460.2012.760649
33. Mokhtar MM and Abdel-Fattah MM. Consanguinity and advanced maternal age as risk factors for reproductive losses in Alexandria, Egypt. *European journal of epidemiology*. 2001 2001;17(6):559-565. doi:10.1023/a:1014567800950.