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Characterization of the Consanguinity in the Moroccan Population of Doukkala

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Abstract: Consanguinity, or the practice of marrying close relatives, is a prevalent phenomenon in many parts of the world, including North Africa. It seems to offer psychological, social, economic, and cultural advantages for couples and their families. In Morocco, the situation of this marital behavior is far from being closely defined. The objective of this research endeavor is to furnish a comprehensive depiction and critical examination of the frequency and trends of consanguinity within the Moroccan population of Doukkala. To investigate the prevalence and patterns of consanguineous marriage in the Doukkala region, a cross-sectional study was conducted in 2019. A structured questionnaire was administrated through face-to-face meetings. The data collected were on place of birth and residence and kinship between the spouses in the case of consanguineous marriage. A sample consisting of 1408 couples was selected randomly from the Doukkala region. The consanguinity rate in this population reaches 26.56% (α = 0.019). The predominant consanguineous union found in the study was the marriage of first cousins. A temporal analysis reveals that consanguinity has experienced a substantial decrease in prevalence, with rates declining from 29.69 to 22.96% over the course of the previous century. The studied population places significant importance on this particular marital behavior within their social imagination and it has yet to be effectively reduced.

Keywords: Morocco, Doukkala, Evolution, Marital Behavior, Consanguinity

Introduction

Consanguinity is a term derived from the Latin word "cumus sanguins", which describes the practice of two individuals who are genetically related by descent and share at least one common ancestor marrying each other (Bittles, 2001). In clinical genetics, consanguinity is defined as a union between second or closer cousins when the coefficient of consanguinity (F) is equal to or greater than 0.0156 (Alwan and Modell, 1997; Bittles, 2001; Modell and Darr, 2002). It is estimated that over one billion people worldwide engage in consanguineous marriage, particularly in Africa and Asia, where it is deeply rooted in certain societies (Bittles and Black, 2010; Hamamy *et al*., 2011; Hamamy, 2012). Arab-Muslim countries are among the

most affected by this practice (Jaber *et al*., 1996; Mehrabi and Zeyghami, 2005; Ali *et al*., 2008).

Consanguinity poses a significant threat to genetic diversity within groups, resulting in decreased favorability and fitness for individuals. The offspring of consanguineous couples display increased homozygosity, which could lead to the expression of deleterious recessive genes in their phenotype (Jacquard and Reynes, 1968; Tchen *et al*., 1977; Solignac *et al*., 1995; Bittles, 2001; Modell and Darr, 2002; Aouar *et al*., 2005; Hamamy *et al*., 2011). Consanguinity also adversely affects fertility and fecundity and increases the risk of congenital malformations, stillbirths, mortality, morbidity, and intellectual disability in their offspring (Edo *et al*., 1985; Bittles *et al*., 1991; Bittles and Black, 2010; Hamamy *et al*., 2011; Tadmouri *et al*., 2012).

The impact of consanguinity is not limited to physical health outcomes but also affects cognitive capacity and contributes to birth defects such as deafness, heart disease, physical and psychological disability, and certain psychoses such as epilepsy, schizophrenia, and bipolar disorders (Morton, 1978; Jaber *et al*., 1997; Becker *et al*., 2001; Bittles, 2002; Bener *et al*., 2007; Kanaan *et al*., 2008; Zlotogora and Shalev, 2010; Bittles and Black, 2010; Al-Kandari and Crews, 2011; Dahdouh-Guermouche *et al*., 2013; Oniya *et al*., 2019).

The present study took place in the Doukkala region of Morocco (Fig. 1), known for its rich cultural heritage and unique blend of Berber, Arab, and European influences. Its location between the Atlantic Ocean and the Atlas Mountains has made it a hub of civilizations and cultures throughout history. Agriculture has been the primary source of income for centuries due to its fertile soil and diverse range of crops, including citrus fruits like oranges, lemons, and grapefruits, as well as traditional crops such as wheat, barley, and olives. The farming practices in Doukkala have been handed down from one generation to the next and are an integral part of the area's culture. From a cultural standpoint, the region is particularly noteworthy, boasting a wealth of tangible and intangible heritage.

Fig. 1: Map of the Doukkala region showing its borders. (Black area represents the sampling location)

In terms of tangible heritage, the area is home to a range of historical, artistic, scientific, and anthropological artifacts, reflecting the unique blend of influences that have shaped the region over time. Meanwhile, the region's intangible heritage is equally significant, encompassing a rich tapestry of traditions, customs, and performing arts that have been passed down from generation to generation (Errami *et al*., 2013; Enniouar *et al*., 2015).

The prevalence of consanguinity in the Doukkala population is the subject of investigation in this study. The research aims to address three main questions concerning this population. Firstly, what is the frequency of consanguinity in the Doukkala population? Secondly, what are the most common types of kinship ties in consanguineous marriages within the Doukkala population? and finally, how has the prevalence of consanguinity changed over time among the Doukkala population? The investigation seeks to provide insights into the prevalence and patterns of consanguineous marriages among the Doukkala people and how these have evolved over time.

Materials and Methods

The Doukkala region was the site of a cross-sectional study in 2019 that utilized a structured questionnaire and face-to-face interviews to gather data on consanguineous marriages. The study sought to acquire information on the place of birth, residence, and kinship between spouses. To ensure the representativeness of the sample, a random selection of 1408 couples residing in the region was conducted.

The survey was conducted in three steps:

- A brief description of the context of the study for the person interested in participating
- Have the interviewee's consent to participate in the study
- This step involves asking people for information through a questionnaire. The data collected were on place of birth and residence, age at marriage of spouses, the kinship between the spouses in the case of consanguineous marriage

For the dates of the different events, date of birth of the participants, age at marriage of the participants, and as we are in front of a population where the rate of illiteracy exceeds 66% in the rural world and the urbanization rate does not exceed 17% (HCP, 2013), we established a relative chronology of the historical events that marked the region or the nation (Baali *et al*., 2005).

The interviewees were selected randomly and the data collected were coded while maintaining the confidentiality and anonymity of the people interviewed.

Consanguinity Coefficient of an Individual F_I

The consanguinity coefficient F_I is calculated from the probability that the two genes owned by an individual at a

given locus are identical by descent (Denic and Al-Gazali, 2002; Denic, 2003):

$$F_1 = \sum (1/2)^{np+nm+1} \ x \left(1+F_{Ai}\right)$$

where:
np: Number of generations that separate the father of the individual *I* from the common ancestor A_i
nm: Number of generations that separate the mother of the individual *I* from the common ancestor A_i
F_{Ai}: The inbreeding coefficient of the ancestor A_i

The Average Coefficient of Consanguinity (α)

The average coefficient of consanguinity (α) was calculated using the following equation (Bittles, 2002):

$$\alpha = \sum fiFi$$

where, *fi* is the relative frequency of individuals with consanguinity coefficient *Fi*.

Consanguineous marriages were categorized according to the degree of kinship between the couples: First cousin (F = 0.0625), double first cousin (F = 0.125), second cousin (F = 0.0156), and cousin once removed (F = 0.0313).

In clinical genetics, the vast majority of marriages are considered consanguineous if the couples are second cousins or closer. Homozygosity rates in marriages beyond the second cousin show minor differences from those observed in the general population and thus may underestimate the true level of homozygosity (Bittles, 2001). As such, distant cousins were removed from the average consanguinity coefficient.

Results and Discussion

Distribution of Consanguinity Types in the Doukkala Community: An Overview

Based on the data collected and analyzed, it was found that consanguinity is prevalent among the Moroccan population of Doukkala. The rate of consanguinity is 26.56%, with an average coefficient of consanguinity α = 0.019 in Table 1.

In terms of consanguinity types, marriages between first cousins are the most common among consanguineous couples in the Moroccan population of Doukkala, representing 56.15% of all consanguineous marriages. This is followed by marriages between double first cousins, which make up 28.61% of all consanguineous unions in Table 1. The consanguinity coefficient of 0.019 indicates a significant level of consanguineous marriages in the Doukkala population, genetically represented.

In the current study, the degree of consanguineous marriage observed is higher than the national consanguinity rate of Morocco, which is 22.79% (Talbi *et al.*, 2007). Among populations within Morocco, Doukkala's

consanguinity rate (26.56%) falls in the middle, with the Gharb-Chrarda-Beni Hssen population at 19.81% (Hami *et al.*, 2005), Rabat-Sale-Zemmour-Zaer population at 20% (Hami *et al.*, 2007) and Tangier Tetouan population at 39.4% (Hardouz *et al.*, 2014).

Compared to European and American populations, where consanguinity rates are generally lower than 5% (Hamamy, 2012), Doukkala's consanguinity rate is high. However, among Arab-Muslim populations, consanguinity rates are substantially higher. For example, the rates are estimated at 35.3% in Egypt (Shawky *et al.*, 2011), 35.9% in Oman (Rajab and Patton, 2000), 36% in Lebanon (Barbour and Salameh, 2009), 37.6% in Libya (Abudejaja *et al.*, 1987), 38% in Tunisia (Zakaria, 1999), 39% in Algeria (Guidoum *et al.*, 2015), 39.8% in Syria (Othman and Saadat, 2009), 40% in Yemen (Jurdi and Saxena, 2003), 46% in the United Arab Emirates (Bener *et al.*, 2001), 47.2% in Mauritania (Hammami *et al.*, 2005), 51% in Qatar (Bener, 2012) and 56% in Saudi Arabia (El Mouzan *et al.*, 2007).

Consanguinity Trends Over Time in the Moroccan Population of Doukkala

Consanguinity refers to the practice of marrying close relatives such as cousins, which is a common practice in some parts of Morocco, including the Doukkala population. The results provided in Table 2 show the percentage of consanguineous marriages and the different types of cousin relationships that were involved in such marriages over four different time periods, namely 1924-1947, 1948-1971, 1972-1995, and 1996-2019.

The findings show a clear decline in the overall percentage of consanguineous marriages in the Doukkala population over the four time periods. From 29.69% in 1924-1947-22.96% in 1996-2019, the percentage of consanguineous marriages decreased by 6.73%. Moreover, the trend towards lower consanguinity rates is more evident in the later time periods, with the percentage of consanguineous marriages dropping from 24.18% in 1972-1995-22.96% in 1996-2019.

In terms of specific cousin relationships, first-cousin marriages were the most prevalent in all four time periods, followed by double first-cousin marriages in the first two periods and distant cousin marriages in the latter two periods. Second-cousin and cousin-once-removed marriages were relatively uncommon in all four time periods.

The average coefficient of consanguinity (α) is a measure of the degree of genetic relatedness between individuals in consanguineous marriages. The results show a decreasing trend in the average coefficient of consanguinity over the four time periods, indicating a reduction in the degree of genetic relatedness between individuals in such marriages. The decrease in α can be attributed to the increasing occurrence of marriages between more distant cousins and a reduction in the frequency of double first-cousin marriages, which are associated with a higher degree of genetic relatedness.

Table 1: Distribution of consanguinity types in the Moroccan population of Doukkala

Degree of consanguinity	(n)	% of the total	Consanguinity coefficient of an individual	Average coefficient of consanguinity
First cousin	210	14.91	0.0625	0.009322
Double first cousin	107	7.60	0.1250	0.009499
A cousin once removed	14	0.99	0.0313	0.000311
Second cousin	7	0.50	0.0156	0.000077
Distant cousin	36	2.56	<0.0156	-
Consanguineous marriage	374	26.56	-	-
Non consanguineous marriage	1034	73.44	0.0000	0.000000
Total	1408			0.019209

Table 2: The evolution of consanguinity during the time

	1924-1947	1948-1971	1972-1995	1996-2019
First cousin	82.00	61.00	39.00	28.00
Double first cousin	46.00	28.00	19.00	14.00
Second Cousin	3.00	2.00	2.00	0.00
A cousin once removed	7.00	5.00	1.00	1.00
Distant cousin	17.00	12.00	5.00	2.00
Consanguineous marriage	155.00	108.00	66.00	45.00
Non consanguineous marriage	367.00	309.00	207.00	151.00
Total	522.00	417.00	273.00	196.00
Consanguinity (%)	29.69	25.89	24.18	22.96
Average coefficient of consanguinity (α)	0.021341	0.017986	0.017768	0.018018

The findings align with the observations made in the populations of Lebanon and Western Algeria (Khlat, 1988; Bou-assy *et al*., 2003; Benkou *et al*., 2018).

Consanguinity has been observed in various societies throughout history, particularly in agricultural societies like Doukkala. The primary reason for consanguineous marriage in such societies is to preserve agricultural assets and ensure the transmission of knowledge and skills across generations. Marrying within the family ensures the continuity of land ownership and prevents its fragmentation through inheritance. Consanguineous marriage also reinforces alliances between families, promoting social and economic cooperation within the community (Kuper, 2009).

Several factors contribute to the prevalence of consanguinity in certain societies. Poverty, religious background, level of education, and the age gap between spouses are significant factors that influence the practice of consanguineous marriage. For instance, Poverty can raise the chances of consanguineous marriage as marrying within the family can alleviate the financial burden of dowry payments and other marriage expenses. Religious beliefs and cultural norms play a significant role in the prevalence of consanguinity. Marrying within the family is considered a religious duty or a way to preserve cultural traditions in some societies. Additionally, the level of education can influence attitudes towards consanguineous marriage. Individuals with lower levels of education are more likely to engage in consanguineous marriage than those with higher levels of education. The age gap between spouses can also influence the prevalence of consanguinity. In societies where men are significantly older than women, marrying a close relative may be seen as a way for women to gain autonomy and privilege within the family. For instance, by marrying a cousin, a woman may have more influence over family decision-making, as she is more closely related to her husband's family (Roy et *al.,* 1991; Danubio, 1997; Talbi *et al*., 2006; Hami *et al*., 2009; Mignot, 2010).

Conclusion

In summary, the study reveals a high consanguinity rate of 26.56% in the Doukkala population, with first cousins being the most common type of union. However, there has been a decrease in consanguinity over the last century, with rates dropping to 22.96%. While this trend is encouraging, efforts to raise awareness about the potential health risks associated with consanguineous marriages and providing education and resources on alternative marriage options, such as marrying outside of the immediate family or seeking genetic counseling, could empower individuals to make informed decisions about their future partners and ultimately reduce the prevalence of consanguineous marriages.

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Author's Contributions

Abderrazak EL Khair: Contributed to the conception and designed of the study, fieldwork, data analysis, and interpretation, and has written the manuscript following the journal's guidelines.

Noura Dahbi and Khadija Cheffi: Have assisted with the fieldwork.

Jalal Talbi: Corrected errors, provided critical feedback, and helped shape the research.

Abderraouf Hilali and Hicham EL Ossmani: Created the initial concept for this study and guided Abderrazak EL Khair through each step of the process.

The ultimate draft of the manuscript was perused and endorsed by all the authors.

Ethical Approval

This study was approved by the Biomedical Research Ethics Committee (CERBC) of Casablanca, Morocco. The Ethics Committee is based on the Declaration of Helsinki 2008.

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