ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

Declining consanguinity in the Jhelum population of Pakistan's Potohar Plateau: Sociodemographic shifts and underlying causes

Sadia Saleem[1], Saif Ullah[2], and Sajid Malik[1]*

[1]Department of Zoology, Faculty of Biological Sciences, Quaid-i-Azam University, Islamabad, Pakistan

[2]Department of Zoology, University of Chitral, Chitral, Khyber Pakhtunkhwa, Pakistan

Abstract

Consanguineous unions (CUs) have long been a common practice and remain prevalent in many cultures, including those in North Africa, West Asia, the Middle East, and developing countries such as Pakistan. As Pakistan undergoes a demographic transition, characterized by rapid urbanization, declining fertility, rising educational attainment, and a shift toward nuclear families, traditional marriage patterns are evolving. Within this context, this study examines the trends and determinants of marital unions in Jhelum District, located in the Potohar region of Pakistan, to explore how societal change influences consanguinity. Using a cross-sectional design, 1,432 married women were randomly recruited from independent households, and data were collected on marital histories and demographic characteristics. The prevalence of CUs was 56%, with a corresponding inbreeding coefficient of 0.0336. First-cousin unions were the most common, accounting for 45% of all marriages. Multivariable logistic regression identified seven significant predictors of consanguinity: Extended family type, husband's occupation, wife's literacy level, caste system, parental consanguinity, reciprocal marriage, and short matrimonial distance. Trend analysis revealed a steady decline in CUs across successive marriage cohorts, particularly after 2010. This decline was observed across all tehsils and was accompanied by an increase in age at marriage. The dynamics of consanguinity and its decline hold important implications for public health, including improved reproductive outcomes, reduced infant and maternal mortality, socioeconomic transition, and long-term population health. Although a gradual nationwide reduction in consanguinity is expected, its pace and magnitude are likely to vary regionally based on cultural norms, socioeconomic development, and rural–urban differences.

Keywords: Close marriage; Cousin marriage; Reciprocal marriage; Inbreeding coefficient; Demographic transition; Pakistan

***Corresponding author:**
Sajid Malik
(malik@qau.edu.pk)

Citation: Saleem S, Ullah S, Malik S. (2026). Declining consanguinity in the Jhelum population of Pakistan's Potohar Plateau: Sociodemographic shifts and underlying causes. *International Journal of Population Studies*. 12(1):67-80.
https://doi.org/10.36922/IJPS025170074

Received: April 22, 2025

1st revised: August 2, 2025

2nd revised: August 20, 2025

3rd revised: September 9, 2025

Accepted: November 6, 2025

Published online: November 26, 2025

1. Introduction

Consanguinity, defined as the union between individuals who are related as second cousins or closer, is a widespread practice in various cultures and regions worldwide (Bhinder *et al.*, 2019; Bittles, 2010). Studies have identified various cultural and sociostructural aspects associated with the high rate of consanguinity, including

patrilineal solidarity, strengthening of family bonds, dowry practices, and limited autonomy in choosing a partner (Bhinder *et al*., 2019; Bittles, 2010; Riaz *et al.,* 2016).

The determinants of consanguinity vary across populations. For instance, cultural norms and religious beliefs play a significant role in consanguineous unions (CUs), particularly among populations in South Asia, the Middle East, and North Africa. In Islam, marriages between first cousins are permitted and sometimes encouraged to strengthen family ties (Bittles, 2012). Similarly, in Hindu and Sikh communities in South Asia, CUs are common among certain castes and sub-groups (Reddy, 2005). Arranged marriages between relatives are viewed as a means to strengthen social bonds and mitigate marital conflicts (Nawaz *et al.,* 2021). Consanguinity is more prevalent in rural areas and among less-educated populations. It also correlates with traditional caste or *biradari* systems (Bittles, 2012; Riaz *et al.,* 2016; Tufail *et al.,* 2017). In land-owning families with established agricultural practices and ruling classes, economic stability and the preservation of inheritance are major drivers of CUs. Families often prefer such unions to keep property and wealth within the kinship network (Shaw, 2001). Hence, the global prevalence of consanguinity varies significantly based on cultural, religious, and socioeconomic contexts, making it a subject of immense demographic and public health interest (Bhinder *et al*., 2019; Jabeen & Malik, 2014). Studying consanguinity is crucial, as it lies at the intersection of culture, demography, and public health. Understanding the patterns and consequences of CUs is essential for guiding genetic counseling, shaping effective public health policies, and designing culturally sensitive interventions, while also providing broader insights into population genetics, marriage systems, and social development.

1.1. Literature review

A high rate of consanguinity is associated with increased prenatal and postnatal morbidity and mortality, adverse reproductive outcomes, and genetic disorders (Bener & Mohammad, 2017; Bittles, 2010; Fareed *et al*., 2017; Nawaz *et al*., 2021). Studies have shown that CUs carry a 1.5- to 2.5-fold higher risk of infant death compared to non-consanguineous marriages (Bittles & Black, 2010). Furthermore, a meta-analysis of diverse populations demonstrated a twofold increase in congenital anomalies among consanguineous offspring (Sheridan *et al*., 2013). Similarly, in Arab populations, 6–8% of newborns from CUs have genetic disorders, compared to 2–3% in non-CUs (Al-Gazali *et al*., 2006). Offspring of CUs also have a higher risk of intellectual disability and developmental delay due to inherited metabolic disorders (Bibi *et al*., 2024; Hamamy *et al*., 2011). Recent studies have shown that certain recessive mutations, which are unmasked by consanguinity, increase susceptibility to malignancies and predispose individuals to cancer (Naffaa & Stolfi, 2021). Therefore, consanguinity represents a significant risk factor for prenatal and postnatal mortality, congenital malformations, and genetic disorders due to the increased homozygosity of deleterious recessive alleles.

A decline in CUs has been observed in Europe and other parts of the world (Fuster & Colantonio, 2004; Shawky *et al*., 2011). In Spain, consanguinity was common in the 20th century and remained stable until the late 1950s, after which it declined rapidly in the following decades; today, it is considered a rare phenomenon (Fuster & Colantonio, 2004). In Jordan, the consanguinity rate was 51% in the 1980s, but declined to 26% by 2018 (Islam, 2021). Similar declining trends have been observed in different populations of India and Pakistan (Malik *et al*., 2024; Sahoo *et al*., 2021). Several factors have been identified as contributing to this decline, including improvements in women's education, delayed age at marriage, the transition to nuclear family structures, urbanization that expands the marriage pool and provides greater anonymity in marital choice, rising socioeconomic status, increased female labor force participation, lower fertility that reduces the pool of cousins as potential spouses, and greater awareness of the genetic risks associated with consanguinity and recessive disorders (Becker, 1992; Ottenheimer, 1996; Schellekens *et al*., 2017; Shawky *et al*., 2011).

In Pakistan, CUs still account for about 50% of all marriages (Hina & Malik, 2015; Nawaz *et al*., 2021). However, the prevalence varies substantially across different regions of the country. Recent studies have documented a gradual decline over time, reflecting changing societal norms, increased awareness of genetic risks, and shifts in marriage practices within the Pakistani population (Ahmad *et al*., 2016; Malik *et al*., 2024).

1.2. Theories of declines in consanguinity

According to the demographic transition theory, as societies move from high to low fertility and mortality regimes, the accompanying social transformations—such as the spread of nuclear family systems, greater female education, and enhanced socioeconomic mobility—reshape traditional kinship and marital practices (Barakat & Basten, 2014; Kirk, 1996; Mair & Anderson, 2024; Notestein, 1945; Shenk *et al*., 2016; Thompson, 1929). Smaller family sizes (a transition from extended family to nuclear family) and urban migration reduce the traditional reliance on kinship networks for marriage. Empirical evidence from several Middle Eastern, North African, and South Asian settings

demonstrates that urbanization and expanded educational opportunities, particularly for women, are associated with a reduced preference for cousin marriages (Bittles, 2012; Hussain & Bittles, 2000; Islam, 2021; Saadat *et al*., 2004).

Similarly, the modernization theory posits that urbanization, industrialization, mass education, and a market economy are fundamental and interconnected forces that have shaped the modern world, eroding traditional social practices (Lerner, 1958; Rostow, 1960). These factors are the key drivers behind the transition from traditional, agrarian societies to the complex, globalized world we are experiencing today. Increased mobility, particularly from rural to urban areas, and exposure to diverse social groups, reduces the pool of kin-based marriages (Islam, 2021; Mair & Anderson, 2024). Literacy, particularly female education, influences marriage preferences toward autonomy and companionate marriages, rather than kinship obligations (Blau & Duncan, 1967; Shenk *et al*., 2016). Furthermore, economic development and structural changes in labor markets promote individual choices in marriage, diminish extended family control over spouse selection, cause a delayed age at marriage, and reduce reliance on kin-based unions (Hamamy, 2012; Islam, 2021; Nalls *et al*., 2009; Naz *et al*., 2023; Shenk *et al*., 2016). The theories of social mobility and individualization (Blau & Duncan, 1967; Islam, 2021; Parsons, 1951) are linked to this, suggesting that with modernization, individuals pursue careers and social mobility beyond family ties.

1.3. Reality in Pakistan

Like many other developing countries, Pakistan is undergoing a rapid demographic transition marked by extensive social, economic, and cultural transformation. Over the past few decades, the country has moved from a traditional, high-fertility, and predominantly rural society toward one that is increasingly urbanized, educated, and economically diversified (Pakistan Bureau of Statistics, 2017; World Bank, 2021). This transformation is reflected in several interrelated trends: A steady decline in fertility rates, a rising median age at marriage, a shift from extended to nuclear family structures, and a growing participation of women in education and the labor force (Afreen *et al*., 2024; Naz et al., 2023).

Urbanization has been one of the most visible indicators of this change, as evidenced by Pakistan's megacities, such as Karachi, Lahore, and Islamabad. This process has altered family living arrangements and social support networks, reducing the dominance of traditional kin-based systems (Afreen *et al*., 2024; Dyson, 2010). The national surveys conducted at various intervals (i.e., Pakistan Demographic and Health Survey) have revealed a consistent decline in the total fertility rate over the past three decades, signaling progress toward later stages of the demographic transition (Naz et al., 2023). Furthermore, economic shifts have influenced marriage timing, gender roles, and intergenerational relations—key components of demographic change. The shift from subsistence-based rural livelihoods to urban wage economies has led to the nuclearization of families, as smaller household units are better adapted to modern labor and housing markets (Dyson, 2010; World Bank, 2021).

These demographic shifts are closely linked to evolving marriage practices, and a decline in CUs, as empirically evident in other geographic regions, can therefore be anticipated (Hamamy, 2012; Islam, 2021; Saadat *et al*., 2004).

1.4. Research questions

Based on these theoretical perspectives, it is reasonable to hypothesize that Pakistan will gradually experience a decline in consanguinity, particularly in regions undergoing rapid socioeconomic development. The motivation for this study stems from the recognition that consanguinity, while deeply rooted in cultural and social traditions of Pakistan, is not static and may be influenced by ongoing socioeconomic transformation in the country. Within this framework, the present study examines patterns of different marital union types in the Jhelum District, northern Punjab, and identifies their dynamics and trends over time, a perspective that makes this study novel. By situating consanguinity within the broader paradigms of demographic transition and modernization, this study seeks to illuminate how large-scale societal changes shape and potentially transform deeply embedded marital practices in Pakistan.

2. Data and methods

2.1. Study population

Jhelum District, located in the Potohar Plateau of Punjab, Pakistan, covers an area of 3,587 km^2 and comprises four subdivisions (tehsils) and 53 union councils. Jhelum District has a total population of 1.38 million, with 61% residing in rural areas (Pakistan Bureau of Statistics, 2017). Punjabi is the primary language spoken. The predominant castes include Rajputs, Jatts, Gujjars, Arains, Maliks, Awans, and Syeds. The district is home to several historically and archaeologically significant sites, including the Khewra Salt Mine, the world's second largest.

For the current study, Jhelum District was selected primarily due to the administrative and logistical support available to carry out data collection and fieldwork. Second, Jhelum District has historically reported a high

consanguinity rate, warranting updated data in light of recent socioeconomic changes and ongoing urbanization, offering a natural setting to explore how modernization intersects with traditional marriage practices. Third, the nearby Potohar districts (e.g., Rawalpindi) show strong *biradari*/endogamy dynamics that sustain consanguineous marriages; Jhelum shares this sociocultural setting, making it an ideal location to examine how local kinship, education, and urbanization shape marriage choices (Fatima & Leghari, 2020). Furthermore, Jhelum is close to Azad Jammu and Kashmir, which has one of the highest consanguinity rates in Pakistan (Jabeen & Malik, 2014). In this context, a large proportion of British Pakistanis trace their roots to the barani zone, which includes the Jhelum, Rawalpindi, and Mirpur districts. Findings from Jhelum have direct implications for the United Kingdom (and Gulf) diaspora, including health services, genetic counseling, and community engagement (Ballard, 2002). Hence, it was worthwhile exploring the consanguinity rate in Jhelum District.

2.2. Ethical approval and sampling strategy

This study was approved by the Ethical Review Committee of Quaid-i-Azam University. A cross-sectional design with multistage stratified random sampling was used to ensure representation across three tehsils, rural and urban areas, and different socioeconomic strata of Jhelum District. Within each tehsil, union councils were randomly selected as primary sampling units. In rural areas, households were approached primarily through door-to-door visits, while in urban areas, participants were recruited from public locations such as hospitals, healthcare facilities, schools, and community centers. After obtaining verbal consent, participants underwent face-to-face interviews and completed questionnaires. No participants were prioritized based on age, education, origin, or other demographic variables.

The inclusion criteria were: (i) ever-married women aged 18 years or older, (ii) permanent residents of Jhelum District, and (iii) individuals who were able and willing to provide informed consent. Exclusion criteria included respondents temporarily residing in Jhelum, visitors, and seasonal migrants. Individuals with cognitive impairments or physical disabilities that limited their ability to provide consent or accurately answer questions were also excluded.

Data were collected over 2 years (2019–2021) in multiple phases, with scheduling determined by the availability of field staff, logistical considerations, and seasonal climatic conditions. Fieldwork was suspended for several months in 2020 due to COVID-19-related restrictions and later resumed in accordance with established safety protocols. The lockdown measures in Jhelum District were comparatively less stringent than those implemented in major metropolitan areas such as Lahore, Karachi, and Islamabad.

2.3. Measures

Information was gathered on marital union types and bio-demographic and socioeconomic variables. The sample size was calculated using the formula for prevalence studies with an estimated consanguinity prevalence of at least 40%. The definitions of variables were adopted from the Pakistan Demographic Health Survey (Hina & Malik, 2015; Nawaz *et al*., 2021; NIPS, 2019; Riaz *et al*., 2016).

All marital union types were grouped into two broad categories: CUs and non-CUs. The CU category included marriages between double first cousins (children of two brothers who married two sisters; i.e., the fathers are brothers and the mothers are sisters), first cousins (children of siblings), first cousins once removed (a marriage between a person and a child of his/her first cousin), and second cousins (children of first cousins). First-cousin marriages were further categorized into four subtypes: father's brother's daughter, father's sister's daughter, mother's brother's daughter, and mother's sister's daughter. The non-CU category comprised marriages between second cousins once removed, distantly related/ *biradari* unions, and non-related unions (Bittles, 2010; Jabeen & Malik, 2014). The aggregate of CU types was utilized to estimate the inbreeding coefficient F, which is a quantitative expression of inbreeding. It is a measure of the probability that two alleles at a given locus in an individual are identical by descent from a common ancestor. It quantifies the degree of genetic relatedness between the parents and thus the level of homozygosity in their offspring (Bittles, 2012).

The participants' tehsil of origin and rural/urban status were obtained from union council records. Tehsils were coded as Dina (1), Jhelum (2), and Sohawa (3), while residence was categorized as urban (1) or rural (2). Family type was defined as either nuclear or extended. Nuclear families consisted of one couple and their children living in the same household, whereas extended families comprised two or more couples across at least three overlapping generations within the same household. Nuclear families were coded as 1, and extended families were coded as 2.

Socioeconomic status and occupations were classified using the standard categories of the Pakistan Demographic and Health Survey (NIPS, 2019). Socioeconomic quartiles were coded as high (1), upper-middle (2), lower-middle (3), and low (4). Occupations of wives were categorized as working women (1) and housewives (2), while occupations

of husbands were grouped as others (1), unskilled manual (2), business (3), skilled manual (4), government jobs (5), and agriculture (6). Literacy was assessed in two ways: (a) formal schooling (literate = 1, illiterate = 2) and (b) number of years of schooling, categorized as ≥13 years (1), 9–12 years (2), and 1–8 years (3). Caste affiliation was coded as Arrain (1), Butt (2), Gujjar (3), Jutt (4), Malik (5), Mughal (6), Rajput (7), Sayyed (8), and others (9). Parental consanguinity was coded as no (1) and yes (2). Reciprocal marriage (locally called *watta-satta*, that is, exchange marriages between two families; often a brother and sister from one family marrying a sister and brother from another family [Zaman, 2013]) was coded as no (1) and yes (2).

Matrimonial distance between the spouses was also taken as a dependent variable. This variable is a key indicator of underlying sociocultural boundaries. It functions as a proxy for social distance, reflecting the tendency for assortative mating based on education, socioeconomic class, rural/urban divide, and ethnicity within geographically bounded groups. In addition, in a society like Pakistan's, where marriages are often arranged by parents/guardians, and familial networks exert considerable influence over marriage formation, the physical distance between spouses directly reflects the geographic reach and embeddedness of these kinship structures.

Matrimonial distance was converted into four categories designed to reflect sociocultural, geographic, and mobility factors that shape marital decisions, aligning with settlement structures, transportation networks, and kinship norms: the first category, <1 km, represents same-village marriages, where spouses live within walking distance. This category is most common in rural, agrarian communities with limited literacy and socioeconomic mobility, often involving cousin unions due to the tightly knit nature of kinship circles. The second category, encompassing distances of 1–10 km, includes adjacent-village or nearby-town marriages, where travel is feasible on foot or by bicycle. Social ties remain strong due to interconnected kin networks across neighboring settlements, often found in extended family structures. The third category, 10–50 km, indicates district-level or inter-tehsil unions, marking a sociocultural boundary where family networks tend to weaken. These marriages are less likely to be consanguineous but often occur within the same *biradari* (caste/subcaste group), influenced by occupational migration or arranged matches beyond immediate kin. The fourth category, 50+ km, encompasses long-distance, inter-district, or inter-provincial marriages, which are typically exogamous in terms of kinship. These unions are often driven by education, employment opportunities, or diaspora linkages, signaling broader social and geographic mobility. Matrimonial distance was categorized as <1 km (1), 1–10 km (2), 10–50 km (3), and 50+ km (4).

2.4. Statistical analysis

The inbreeding coefficient F was calculated based on the proportion of CU types within the total marriages in each respective category (Bittles, 2010).

Descriptive statistics were applied to summarize categorical variables, and the significance of deviations from a random distribution was assessed at $p<0.05$. Consanguinity was analyzed as an independent variable, with demographic variables (i.e., dependent variables: tehsil, rural/urban origin, family type, socioeconomic status, wife's occupation, wife's literacy, husband's occupation, husband's literacy, caste system, reciprocal marriage, matrimonial distance) evaluated in relation to it. The odds of CUs were calculated across each dependent variable (and expressed in odds ratios [OR]), with the lowest category taken as the reference. The corresponding 95% confidence intervals (CIs) were calculated. Multivariable analyses were conducted using logistic regression, performed in multiple tiers. Consanguinity, the independent variable, was treated as a dichotomous variable: yes (1) versus no (0), and dependent variables were incorporated into the step-by-step model. Significant variables were retained in the model, and the results were expressed in OR. The analyses were repeated using sampling weights for tehsils to adjust for over- and under-representation of the samples.

Model diagnostics were performed to assess the adequacy and robustness of the logistic regression model (Pagano *et al*., 2022). Goodness-of-fit was evaluated using the Hosmer–Lemeshow test and pseudo-R^2 statistics. Model discrimination was assessed using the area under the receiver operating characteristic curve and classification accuracy. Multicollinearity among predictors was examined using variance inflation factors, with values <5 indicating acceptable levels. Influential observations and outliers were assessed through standardized residuals, leverage values, and Cook's distance.

Data analyses were performed to assess trends in CUs and marital patterns over time. Participants were stratified by current age, husband's age, and marriage year, grouped into 10-year intervals for analysis. Furthermore, specific types of first-cousin unions were analyzed separately to identify shifts in preferential marital patterns. The average age at marriage was also calculated for each time interval. Trends were analyzed for the total population and were also stratified by the three tehsils. All data were analyzed using GraphPad Prism (version 5) and STATA (version 13).

3. Results

3.1. Data structure and rate of consanguinity

A total of 1,432 women from separate households were recruited for the study. The mean age of the participants was 41.21 ± 9.73 years. The representation of individuals from three tehsils—Dina, Jhelum, and Sohawa—was 58%, 24%, and 18%, respectively (Table 1). The participants were predominantly from rural areas (64%), nuclear families (61%), and the low to lower-middle socioeconomic quartiles (75%).

3.2. Consanguinity across sociodemographic variables

Across the tehsils, the prevalence of CUs was comparable in Dina and Jhelum (54% each), whereas Sohawa exhibited a significantly higher proportion (67%) (Table 1). The corresponding inbreeding coefficients were calculated to be 0.0322, 0.0319, and 0.0407, respectively, yielding an overall inbreeding coefficient of 0.0336 (Table 1).

Table 2 shows that the odds of consanguinity were higher in individuals originating from Sohawa tehsil (OR: 1.74; 95% CI: 1.30–2.34), rural areas (OR: 1.13; 95% CI: 0.91–1.41), extended families (OR: 1.43; 95% CI: 1.15–1.78), and the lower-middle socioeconomic quartile (OR: 1.59; 95% CI: 1.01–2.50), in bivariate analyses. The rate of consanguinity was relatively higher in women who were housewives (OR: 1.07; 95% CI: 0.69–1.67) and whose husbands were engaged in agriculture (OR: 1.10; 95% CI: 0.72–1.68). The rate of CUs did not differ significantly with respect to the literacy of participants or their spouses. However, among literate individuals, a declining trend in CUs was evident with increasing literacy levels (Table 2).

The odds of consanguinity were significantly lower in the Arrain (OR: 0.54; 95% CI: 0.32–0.93) and Mughal caste systems (OR: 0.58; 95% CI: 0.35–0.97), in bivariate analyses. The odds of consanguinity were significantly higher in individuals who had parental consanguinity (OR: 3.58; 95% CI: 2.82–4.54) and reciprocal marriages (OR: 5.48; 95% CI: 3.56–8.42) (Table 2). Furthermore, the rate of CUs decreased as the matrimonial distances increased, with the lowest rate observed for distances of 50+ km (OR: 0.26; 95% CI: 0.19–0.37).

In the multivariable model, all variables were incorporated in the analyses. Seven variables were significant predictors of consanguinity: family type, husband's occupation, wife's literacy level, caste system, parental consanguinity, reciprocal marriage, and matrimonial distance (Table 2). The analyses were revised after adjusting for the sampling weights of tehsils according to the census data. The analyses revealed that the predictive

Table 1. Sample distribution, prevalence of consanguineous unions, and inbreeding coefficient across demographic and socioeconomic variables

Variables	*n*	% of sample	% of CUs	Inbreeding coefficients
Total sample	1,432	100	56	0.0336
Tehsil				
Dina	830	58	54	0.0322
Jhelum	347	24	54	0.0319
Sohawa	255	18	67	0.0407
Rural/urban origin				
Urban	511	36	54	0.0305
Rural	921	64	57	0.0353
Family type				
Nuclear	871	61	53	0.0309
Extended	561	39	62	0.0378
Socioeconomic quartile				
Low	430	30	55	0.0339
Lower-middle	646	45	58	0.0344
Upper-middle	270	19	57	0.0339
High	86	6	47	0.0251
Wife's occupation				
Housewife	1,348	94	56	0.0340
Working women	84	6	55	0.0279
Husband's occupation				
Agriculture	118	8	61	0.0377
Government jobs	354	25	59	0.0355
Skilled manual	366	26	56	0.0337
Business	289	20	54	0.0311
Unskilled manual	185	13	58	0.0345
Others	120	8	49	0.0284
Wife's literacy				
Literate	1,019	71	56	0.0334
Illiterate	413	29	56	0.0342
Wife's literacy level				
1^{st}–8^{th}	538	53	61	0.0372
9^{th}–12^{th}	406	40	52	0.0292
13^{th} or above	75	7	49	0.0279
Husband's literacy				
Literate	1,258	88	57	0.0338
Illiterate	174	12	53	0.0323
Husband's literacy level				
1^{st}–8^{th}	416	33	60	0.0358
9^{th}–12^{th}	719	57	56	0.0332
13^{th} or above	123	10	50	0.0305

(Cont'd...)

Table 1. ***(Continued)***

Variables	*n*	% of sample	% of CUs	Inbreeding coefficients
Caste system				
Arrain	68	5	41	0.0237
Butt	86	6	57	0.0374
Gujjar	150	10	63	0.0379
Jutt	280	20	58	0.0352
Malik	166	12	58	0.0341
Mughal	76	5	45	0.0245
Rajput	356	25	61	0.0369
Sayyed	105	7	50	0.0253
Others	145	10	52	0.0307
Parental consanguinity				
Yes	524	37	75	0.0456
No	908	63	46	0.0267
Reciprocal marriage				
No	1,251	87	52	0.0305
Yes	181	13	86	0.0550
Matrimonial distance (km)				
<1	388	27	76	0.0462
1–10	375	26	52	0.0310
10–50	427	30	48	0.0285
50+	242	17	45	0.0264

Note: Percentages of sample distribution and prevalence of CUs are unweighted.
Abbreviation: CU: Consanguineous union.

strength of the wife's literacy level on consanguinity increased, and the strength of parental consanguinity and exchange marriage slightly decreased.

3.3. Subtypes of consanguineous and non-consanguineous marriages

Table 3 shows that 56% of individuals had CUs. Among the CUs, first-cousin unions had the highest representation at 45%, whereas double first-cousin, first-cousin once removed, and second-cousin unions accounted for 3%, 4%, and 4%, respectively (Table 3). Among the first-cousin unions, father's brother's daughter marriages were more prevalent (33%), whereas father's sister's daughter, mother's brother's daughter, and mother's sister's daughter marriages were 21%, 21%, and 24%, respectively. The differences in the distribution of first-cousin union types across the tehsils were not statistically significant (p=0.193).

3.4. Trends in CUs

The distribution of marriage types according to current age revealed that the rate of CUs was declining with declining age intervals of participants (i.e., younger individuals with less consanguinity), but not with the age of the husband (Table 4). Regarding the marriage year, a declining trend in CUs was observed in the 10-year age interval data (Table 4 and Figure 1A). This declining trend was observed in the total data as well as across three tehsils. Nonetheless,

Table 2. Odds ratios of predictors of consanguinity in multivariable logistic models

Variables	Bivariate model[a]	Multivariable model[b]
Tehsil Jhelum (Dina)	1.03	0.94
Tehsil Sohawa (Dina)	1.74***	1.32
Rural origin (Urban)	1.13	0.90
Extended family (Nuclear)	1.43***	1.38*
Socioeconomic low quartile (High)	1.41	1.13
Socioeconomic lower-middle quartile (High)	1.59*	1.08
Socioeconomic upper-middle quartile (High)	1.55+	0.98
Housewife (Working women)	1.07	0.80
Husband's occupation: Agriculture (Government job)	1.10	0.59+
Skilled manual (Government job)	0.82	0.61*
Business (Government job)	0.88	0.71
Unskilled manual (Government job)	0.98	0.77
Others (Government job)	0.68+	0.59
Wife's illiterate (Literate)	1.00	1.05
Wife's literacy level: 1st–8th (13th or above)	1.59+	2.03*
Wife's literacy level: 9th–12th (13th or above)	1.10	1.44
Husband illiterate (Literate)	0.87	1.07
Husband's literacy level: 1st–8th (13th or above)	1.45+	1.73+
Husband's literacy level: 9th–12th (13th or above)	1.26	1.49
Arrain (Jutt)	0.54*	1.40
Butt (Jutt)	0.93	1.67+
Gujjar (Jutt)	1.19	1.11
Malik (Jutt)	1.04	1.06
Mughal (Jutt)	0.58*	0.86
Rajput (Jutt)	1.30	2.03**
Sayyed (Jutt)	0.67+	0.89
Others (Jutt)	0.89	1.44
Parental consanguinity (No)	3.58***	3.39***
Reciprocal marriage (No)	5.48***	4.94***
Matrimonial distance 1–10 km (<1)	0.34***	0.31***
Matrimonial distance 10–50 km (<1)	0.29***	0.33***
Matrimonial distance 50+km (<1)	0.26***	0.29***

Notes: Category in the parentheses is the reference group. Statistical significance determined at+p < 0.1, *p<0.05, **p<0.01, ***p<0.001.
[a]Unweighted model; [b]Weighted model.

Table 3. Subtypes of consanguineous and non-consanguineous marriages

Variables	Consanguineous union, *n* (%) [a]				Non-consanguineous union, *n* (%) [a]			Total, *n* (%) [b]
	DFC	FC	FCOR	SC	SCOR	DR	NR	
Tehsil								
Dina	16 (2)	375 (45)	24 (3)	32 (4)	0 (0)	139 (17)	244 (29)	830 (58)
Jhelum	13 (4)	134 (39)	26 (7)	16 (5)	0 (0)	63 (18)	95 (27)	347 (24)
Sohawa	9 (4)	140 (55)	10 (4)	12 (5)	1 (0)	35 (14)	48 (19)	255 (18)
Total	38 (3)	649 (45)	60 (4)	60 (4)	1 (0)	237 (17)	387 (27)	1,432 (100)
Rural/urban origin								
Urban	7 (1)	214 (42)	29 (6)	28 (5)	0 (0)	94 (18)	139 (27)	511 (36)
Rural	31 (3)	435 (47)	31 (3)	32 (3)	1 (0)	143 (16)	248 (27)	921 (64)

Notes: [a]Numbers in parentheses refer to proportions of different marriage types among the total marriages in each tehsil and in urban and rural areas; [b]Numbers in parentheses refer to proportions of samples shared by each tehsil and urban and rural areas. Chi-square tests were performed among tehsils ($p<0.001$) and between rural and urban origins ($p=0.0111$).
Abbreviations: DFC: Double first-cousin; DR: Distantly related; FC: First cousin; FCOR: First cousin once removed; NR: Non-related; SC: Second cousin; SCOR: Second cousin once removed.

Table 4. Consanguinity and inbreeding coefficient across age strata and marriage years

Variables	Consanguineous unions, *n* (%)		Total marriages, *n* (%)		Odds ratio	*p*-value	95% confidence interval	Inbreeding coefficient
Current age (years, wife)								
Up to 30	109	53	204	14	Ref.	-	-	0.0332
31–40	272	55	497	35	1.05	0.098	0.76–1.46	0.0326
41–50	318	57	554	39	1.17	0.329	0.85–1.62	0.0330
51–60	108	61	177	12	1.36	0.136	0.91–2.05	0.0388
Total	807	56	1,432	100				0.0336
Current age (years, husband)								
Up to 30	66	57	116	8	Ref.	-	-	0.0350
31–40	140	55	255	18	0.92	0.720	0.59–1.44	0.0336
41–50	359	59	607	42	1.10	0.650	0.73–1.64	0.0342
51–60	219	54	406	28	0.89	0.573	0.59–1.35	0.0329
Marriage year[a]								
Up to 1980	63	68	93	6	2.67	0.001	1.51–4.70	0.0423
1981–1990	222	58	386	27	1.72	0.010	1.13–2.60	0.0341
1991–2000	361	56	648	45	1.60	0.020	1.08–2.37	0.0329
2001–2010	109	58	187	13	1.77	0.015	1.11–2.83	0.0358
>2010	52	44	118	8	Ref.	-	-	0.0257
Age at marriage (years, wife) [a]								
Up to 20	565	58	974	68	1.63	0.008	1.13–2.34	0.0348
20–25	180	56	323	23	1.48	0.055	0.99–2.22	0.0325
>25	62	46	135	9	Ref.	-	-	0.0275

Notes: [a]Differences in the distribution were statistically significant in the Chi-square test statistics. Ref. refers to the reference.

the marital alliance system underwent drastic changes, and a matrilineal shift accelerated after 1991, but became more pronounced after 2010 (Figure 1B). Further distribution of first-cousin unions revealed that there was a remarkable decline in father's brother's daughter and mother's brother's daughter marriages, whereas mother's sister's daughter marriages increased significantly (Figure 1C). The age at marriage was observed to increase steadily across time

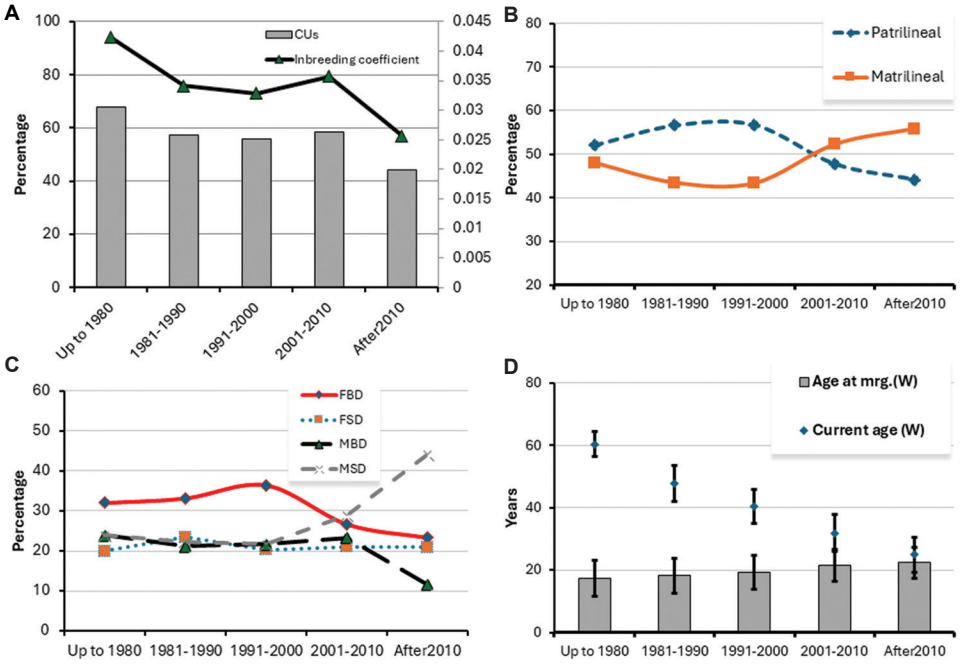

Figure 1. Trend in consanguinity in the Jhelum population. (A) Temporal decline in consanguineous unions (bar graph) and inbreeding coefficient (line graph). (B) Temporal shifts in patrilineal and matrilineal marriages. (C) Temporal changes in first cousin marriage types. (D) Temporal rise in the average age of women at marriage.
Abbreviations: CU: Consanguineous marriage; FBD: Father's brother's daughter; FSD: Father's sister's daughter; MBD: Mother's brother's daughter; Mrg: Marriage; MSD: Mother's sister's daughter.

intervals (Figure 1D). Regarding the age of participants, a declining trend in consanguinity was observed with decreasing age intervals (Table 4).

4. Discussion

This study was conducted to quantify and analyze the patterns of CUs in Jhelum District, located in the Potohar Plateau of Punjab, Pakistan, and to examine their sociodemographic determinants. High rates of CUs have been linked to an increased risk of autosomal recessive disorders, higher infant mortality, and adverse reproductive outcomes (Bener & Mohammad, 2017; Bibi *et al.*, 2024; Fareed *et al.*, 2017; Naqvi *et al.*, 2023; Nawaz *et al.*, 2021; Shawky *et al.*, 2011). Pakistan ranks among the countries with the highest prevalence of consanguinity worldwide; however, population-based studies providing detailed sociodemographic analysis remain limited for specific districts such as Jhelum.

The overall frequency of consanguinity in Jhelum District is 56%; however, it varies considerably across the tehsils. It was significantly higher in Sohawa (67%) compared to Jhelum and Dina (both at 54%). A likely explanation for this finding is that Sohawa, which remains predominantly agrarian, has low population density, low literacy, and more entrenched tribal structures where endogamy is a deeply rooted norm used to preserve family wealth, social status, and kinship ties (Pakistan Bureau of Statistics, 2017). In contrast, Dina and Jhelum are more urbanized and economically diversified, and their lower rates of CUs may reflect greater exposure to diverse social networks and weaker adherence to traditional marriage customs. Consanguinity has generally been inversely related to urbanization, as rural settings are often characterized by social isolation, strong family ties, extended households, lower literacy, early marriages, and shorter birth intervals, all of which favor CUs (Malik *et al.*, 2024; Riaz *et al.*, 2016; Schellekens *et al.*, 2017; Shawky et al., 2011).

A strong predictor of an individual's choice of a CU is their parents' marriage type. This study's findings align with existing literature (Ahmad *et al.*, 2016; Nawaz *et al.*, 2021). It is pertinent to note that exchange marriage is deeply rooted in certain rural and tribal areas of Pakistan, particularly in the provinces of Punjab, Sindh, and Khyber Pakhtunkhwa. Although the contribution of exchange marriage accounted for only 13% of total marital unions, it appears to be a strong predictor of consanguinity.

Another reason for the decline in CUs in the study population could be the increase in matrimonial distance over the years, that is, the distance increased from 25.4 ± 56.7 km in marriages commenced before

1980 to 68.6 ± 184.6 km in marriages commenced after 2010 (data not shown). Matrimonial distance is inversely related to consanguineous marriages—greater distance reduces the likelihood of unions between relatives (Calderón *et al*., 2018; Nawaz *et al*., 2021). Higher matrimonial distance decreases the probability of CUs because partners are less likely to be biologically related (Balgir *et al*., 2013; Reddy, 1988). Rural areas often have extended families with large marriage pools, which increases the likelihood of consanguineous marriages. Urban areas typically experience greater matrimonial distance due to smaller family sizes, migration, education, and diverse social networks, resulting in lower consanguinity.

The multivariable regression analyses revealed that seven variables, that is, extended family type, husband's occupation, wife's literacy level, caste system, parental consanguinity, reciprocal marriage, and very close matrimonial distance (<1 km), were significant predictors of CUs; yet the strongest effects were measured for reciprocal marriage, parental consanguinity, and very close matrimonial distance, in both weighted and unweighted logistic models (Table 2). These findings provide empirical support for both the demographic transition theory and the modernization theory. The demographic transition theory and modernization theory converge on the factors of education, mobility, nuclearization, and urbanization, which collectively contribute to a decline in consanguinity.

The key demographic transitions in Jhelum's population over the past two decades include an increase in the urban population from 18% in 1998 to 29% in 2017, largely due to rural-to-urban migration, which was partly driven by the expansion of military cantonments, the development of industrial zones along the Grand Trunk Road, and the growth of educational hubs. Literacy rates rose from 50% in 1998 to 64% in 2017, while the proportion of the workforce employed in agriculture declined from 35% to 22%. At the same time, there has been a significant outmigration of youth to the cosmopolitan areas of Rawalpindi and Islamabad in search of employment, as well as high levels of international migration, particularly to the Gulf and European countries (Pakistan Bureau of Statistics, 2017).

Conversely, the lower odds of consanguinity in nuclear families and in marriages spanning greater geographic distances reflect the processes of urbanization, mobility, and the weakening of kinship control emphasized by modernization theory. However, the strong influence of reciprocal marriages indicates that despite structural transformations, cultural strategies to preserve kinship solidarity continue to reinforce CUs, highlighting the uneven and context-specific nature of the transition.

The current study revealed a declining trend in CUs over time, as well as with decreasing participant age. The lower rate of consanguinity in younger age groups may be attributed to greater awareness of the potential implications of CUs. This awareness is likely linked to rising literacy levels among younger individuals. A similar pattern was observed with education, as higher educational attainment was associated with reduced rates of consanguinity. In addition, the age at marriage has steadily increased over successive time intervals, and this increase is inversely related to consanguinity rates (Bashir & Nazir, 2022; Malik *et al*., 2024; Schellekens *et al*., 2017). With higher literacy, women are increasingly contributing to household income through diverse professions and playing a more active role in decision-making related to marriage. This shift has led to an increase in matrilineal marriages, as women often exhibit a natural inclination toward their own families.

A shift from a patrilineal to a matrilineal system entails a significant reorganization of how families and communities structure kinship, inheritance, and living arrangements. In patrilineal systems, family ties, property, and authority are typically passed down through the male line. In matrilineal systems, descent is traced through women, with couples often living near the wife's family, property passing through the mother's side, and maternal relatives, especially the mother's brothers, assuming important roles. This is a likely scenario in the Jhelum population, where a large number of men have migrated to Europe and Gulf countries for employment (Pakistan Bureau of Statistics, 2017). In the absence of a husband, the role of mother and maternal uncles increases in marital decisions. Similar shifts have been observed in the Kashmir population of Pakistan (Jabeen & Malik, 2014).

Taken together, our study demonstrates that the combined effect of several variables has led to the decline of consanguinity, a finding that aligns with both demographic transition theory and modernization theory (Islam, 2021; Mair & Anderson, 2024; Notestein, 1945; Rostow, 1960). This decline in consanguinity, along with the increase in age at marriage and greater matrimonial distance, reflects broader social transformations associated with fertility decline, higher educational attainment, urbanization, and mobility. These findings align with the demographic transition theory, which posits that shifts in demographic regimes lead to changes in kinship and marital practices. Similarly, the observed cohort shifts support the modernization theory's emphasis on the weakening control of the extended family (i.e., a move toward nuclear families), the rise of individual choice, and the trend toward delayed marriages. Notably, the increase in matrilineal marriages (alongside a decline in patrilineal ones) points

to a restructuring of kinship strategies rather than their complete disappearance. This suggests that the transition is adaptive and context-specific, not a simple linear process.

This study has several potential applications. Foremost is its relevance to public health planning. Quantifying the prevalence and determinants of CUs supports evidence-based policies for community genetic screening programs, similar to initiatives implemented in other high-consanguinity countries such as Saudi Arabia, Iran, and across the Middle East (Abou Tayoun *et al*., 2021; Al-Gazali *et al*., 2006; Hamamy *et al*., 2011). The high CU rate (56%) identified here underscores the need for expanded genetic counseling and prenatal screening services to reduce the burden of recessive disorders, particularly in the socioeconomic groups highlighted by this study. Identifying sociodemographic predictors (e.g., low matrimonial distance, extended family type) enables targeted interventions, including health education campaigns directed toward high-risk groups. Moreover, the decline in CUs among younger cohorts is an important indicator of shifting marriage practices, likely linked to urbanization, education, and changing socioeconomic norms. Understanding CU prevalence is critical for anticipating the future burden of congenital and genetic disorders and for developing preventive strategies. Finally, this study provides a model for similar investigations in other regions with high consanguinity, such as the Middle East and North Africa.

The findings of this study hold significant relevance for a wide range of stakeholders, particularly public health authorities such as the Ministry of National Health Services, Pakistan, and the Punjab Health Department. These insights can guide the development of community-specific health awareness campaigns, reproductive health risk mitigation strategies, and genetic counseling programs. Reproductive health practitioners and maternal and child health workers can utilize these findings to implement targeted screening for at-risk couples and families, enabling early intervention. In addition, genetic counselors and medical geneticists can utilize this research to provide more accurate risk assessments and informed management advice to couples considering marriage.

Beyond the medical field, the study offers valuable insights for sociologists and anthropologists examining family structures and cultural shifts in marriage patterns across South Asia. The data may also inform policymakers and non-governmental organizations working on women's health, child survival, and socioeconomic development, as CUs trends are closely tied to demographic transitions and education patterns. Ultimately, the findings can empower families and community activists to make informed decisions about marriage, thereby fostering healthier and more sustainable family structures in the long term.

Based on the study findings and in line with international best practices (Abou Tayoun *et al*., 2021; Bittles & Black, 2010; Shenbagam *et al*., 2025), we recommend a multi-pronged approach to address the health implications of CUs. First, community-based genetic counseling programs should be implemented with a focus on pre-marital and pre-conception counseling to mitigate risks. Second, healthcare providers—especially physicians—should receive specialized training in prenatal diagnostics to enable early detection of recessive genetic disorders. Third, culturally sensitive awareness campaigns should be developed to educate families with strong endogamous traditions about the potential health risks associated with CUs. In addition, integrating genetic risk education into school/college curricula could empower younger generations to make informed decisions about marriage and reproduction. To track long-term trends, longitudinal surveillance should be established in Jhelum and other high-prevalence regions to monitor CUs rates and their correlation with genetic disease burden. Ultimately, intersectoral collaboration among healthcare professionals, educators, and community leaders is crucial to align cultural practices with public health objectives, thereby ensuring sustainable and respectful health promotion strategies.

This study may have the following limitations. As in other epidemiological studies, recall biases may be present in the self-reported data in this study. The study had a sampling imbalance across tehsils, which may have influenced the representativeness of the results. Nevertheless, we applied sampling weights in our analyses, which likely minimized the potential biases from non-representativeness. The recruitment of urban participants primarily from hospitals, educational institutions, and community centers may have introduced potential selection bias. In certain areas, convenience-based sampling was adjusted for the availability of participants, which may have introduced possible logistical bias. Furthermore, this study does not report the fertility record of the respondents. In addition, the impact of CUs on reproductive outcomes, morbidity, and congenital anomalies is not reported here. Nonetheless, the findings of this study may not apply to areas with lower consanguinity rates.

5. Conclusion

This study investigates the dynamics of CUs in various bio-demographic variables of the Jhelum population. This study revealed that seven variables (i.e., extended family type, husband's occupation, wife's literacy level,

caste system, parental consanguinity, reciprocal marriage, and matrimonial distance) were significant predictors of consanguinity. The rate of CUs declined over time, and the younger generation shows lower CU rates than the older generation. It is recommended to launch proactive public health measures to sustain and accelerate the decline of consanguinity, particularly by engaging communities, promoting awareness, and integrating genetic services into primary healthcare frameworks. It is anticipated that other populations in Pakistan will witness a gradual decline in consanguinity, especially in economically developing areas, although the pace and extent of this change may vary regionally due to cultural traditions, levels of development, and rural–urban differences.

Acknowledgments

The authors extend their gratitude to the participants for their voluntary participation in this study.

Funding

None.

Conflict of interest

The authors declare that they have no competing interests.

Author contributions

Conceptualization: Sajid Malik
Data curation: Sadia Saleem, Sajid Malik
Formal analysis: All authors
Investigation: Sajid Malik
Methodology: Sajid Malik
Project administration: Sajid Malik
Resources: Sajid Malik
Software: Sajid Malik
Supervision: Sajid Malik
Validation: Saif Ullah, Sajid Malik
Visualization: Saif Ullah, Sajid Malik
Writing–original draft: All authors
Writing–review & editing: All authors

Ethics approval and consent to participate

This study was approved by the Ethical Review Committee of Quaid-i-Azam University, Islamabad, Pakistan (Approval no.: DAS-19, July 3, 2019). Verbal consent was obtained from each subject before participation in data collection.

Consent for publication

Verbal consent was obtained from the participants to publish their data.

Availability of data

The data are available from the corresponding authors on reasonable request.

References

Abou Tayoun, A.N., Fakhro, K.A., Alsheikh-Ali, A., & Alkuraya, F.S. (2021). Genomic medicine in the Middle East. *Genome Medicine*, 13(1):184.

https://doi.org/10.1186/s13073-021-01003-9

Afreen, K., Ordine, P., & Rose, G. (2024). Association between education and fertility: New evidence from the study in Pakistan. *Economies*, 12(10):261.

https://doi.org/10.3390/economies12100261

Ahmad, B., Rehman, A.U., & Malik, S. (2016). Consanguinity and inbreeding coefficient in tribal Pashtuns inhabiting the turbulent and war-affected territory of Bajaur Agency, north-west Pakistan. *Journal of Biosocial Science*, 48(1): 113-128.

https://doi.org/10.1017/S0021932014000558

Al-Gazali, L., Hamamy, H., & Al-Arrayad, S. (2006). Genetic disorders in the Arab world. *BMJ*, 333(7573):831-834.

https://doi.org/10.1136/bmj.38982.704931.ae

Balgir, R.S. (2013). Contribution of marital distance to community inbreeding, homozygosis, and reproductive wastage for recessively inherited genetic disorders in Madhya Pradesh, India. *Mediterranean Journal of Hematology and Infectious Diseases*, 5(1):e2013054.

https://doi.org/10.4084/MJHID.2013.054

Ballard, R. (2002). The South Asian presence in Britain and its transnational connections. In: Singh, H., & Vertovec, S., (eds.), Culture and Economy in the Indian Diaspora. London: Routledge.

Barakat, B., & Basten, S. (2014). Modelling the constraints on consanguineous marriage when fertility declines. *Demographic Research*, 30:277-312.

https://doi.org/10.4054/DemRes.2014.30.9

Bashir, S., & Nazir, S. (2022). Marriage market in Pakistan: Consanguinity, educational assortative mating, and fertility. *PIDE Working Papers*, 2022(1):1-20.

Becker, G.S. (1992). Fertility and the economy. *Journal of Population Economics*, 5(3):185-201.

Bener, A., & Mohammad, R.R. (2017). Global distribution of consanguinity and their impact on complex diseases: Genetic disorders from an endogamous population. *Egyptian Journal of Medical Human Genetics*, 18(4):315-320.

https://doi.org/10.1016/j.ejmhg.2017.01.002

Bhinder, M.A., Sadia, H., Mahmood, N., Qasim, M., Hussain, Z., Rashid, M.M., *et al.* (2019). Consanguinity: A

blessing or menace at population level? *Annals of Human Genetics*, 83(4):214-219.

https://doi.org/10.1111/ahg.12308

Bibi, A., Ji, W., Jeffries, L., Zerillo, C., Konstantino, M., Mis, E.K., *et al.* (2024). Exome sequencing reveals genetic heterogeneity in consanguineous Pakistani families with neurodevelopmental and neuromuscular disorders. *American Journal of Medical Genetics Part C: Seminars in Medical Genetics*, 196(4):e32103.

https://doi.org/10.1002/ajmg.c.32103

Bittles, A.H. (2010). Consanguinity, genetic drift, and genetic diseases in populations with reduced numbers of founders. In: Speicher, M.R., Antonarakis, S.E., & Motulsky, A.G., (eds.), Vogel and Motulsky's Human Genetics. Berlin: Springer. p507-728.

Bittles, A.H. (2012). Consanguinity in Context. Cambridge: Cambridge University Press.

Bittles, A.H., & Black, M.L. (2010). Evolution in health and medicine Sackler colloquium: Consanguinity, human evolution, and complex diseases. *Proceedings of the National Academy of Sciences of the United States of America*, 107(Suppl 1):1779-1786.

https://doi.org/10.1073/pnas.0906079106

Blau, P.M., & Duncan, O.D. (1967). The American Occupational Structure. New Jersey: Wiley.

Calderón, R., Hernández, C.L., García-Varela, G., Masciarelli, D., & Cuesta, P. (2018). Inbreeding in southeastern Spain: The impact of geography and demography on marital mobility and marital distance patterns (1900–1969). *Human Nature*, 29(1):45-64.

https://doi.org/10.1007/s12110-017-9305-z

Dyson, T. (2010). Population and Development: The Demographic Transition. London: Zed Books.

Fareed, M., Ahmad, M.K., Anwar, M.A., & Afzal, M. (2017). Impact of consanguineous marriages and degrees of inbreeding on fertility, child mortality, secondary sex ratio, selection intensity, and genetic load: A cross-sectional study from Northern India. *Pediatric Research*, 81(1-1):18-26.

https://doi.org/10.1038/pr.2016.177

Fatima, B., & Leghari, I.U. (2020). Social determinants of cousin marriages: A case study of District Rawalpindi, Pakistan. *FWU Journal of Social Sciences*, 14(2):155-163.

Fuster, V., & Colantonio, S.E. (2004). Socioeconomic, demographic, and geographic variables affecting the diverse degrees of consanguineous marriages in Spain. *Human Biology*, 76(1):1-14.

https://doi.org/10.1353/hub.2004.0021

Hamamy, H. (2012). Consanguineous marriages: Preconception consultation in primary health care settings. *Journal of Community Genetics*, 3(3):185-192.

https://doi.org/10.1007/s12687-011-0072-y

Hamamy, H., Antonarakis, S.E., Cavalli-Sforza, L.L., Temtamy, S., Romeo, G., Kate, L.P., *et al.* (2011). Consanguineous marriages, pearls and perils: Geneva International Consanguinity Workshop Report. *Genetics in Medicine*, 13(9):841-847.

https://doi.org/10.1097/GIM.0b013e318217477f

Hina, S., & Malik, S. (2015). Pattern of consanguinity and inbreeding coefficient in Sargodha District, Punjab, Pakistan. *Journal of Biosocial Science*, 47(6):803-811.

https://doi.org/10.1017/S0021932014000431

Hussain, R., & Bittles, A.H. (2000). Sociodemographic correlates of consanguineous marriage in the Muslim population of India. *Journal of Biosocial Science*, 32(4):433-442.

https://doi.org/10.1017/S0021932000004338

Islam, M.M. (2021). Consanguineous marriage and its relevance to divorce, polygyny, and survival of marriage: Evidence from a population-based analysis in Jordan. *Annals of Human Biology*, 48(1):30-36.

https://doi.org/10.1080/03014460.2021.1877354

Jabeen, N., & Malik, S. (2014). Consanguinity and its sociodemographic differentials in Bhimber District, Azad Jammu and Kashmir, Pakistan. *Journal of Health, Population and Nutrition*, 32(2):301-313.

Kirk, D. (1996). Demographic transition theory. *Population Studies*, 50(3):361-387.

https://doi.org/10.1080/0032472031000149536

Lerner, D. (1958). The Passing of Traditional Society: Modernizing the Middle East. United States: The Free Press.

Mair, C., & Anderson, R. (2024). Global demographic-cultural shifts and "kinlessness": Reconsidering intergenerational theories. *Innovation in Aging*, 8(Suppl 1):1315.

https://doi.org/10.1093/geroni/igae098.4201

Malik, S., Bibi, A., Farid, R., Khan, S., Awan, J., & Rehman, A.U. (2024). Consanguinity in northwest Pakistan: Evidence of temporal decline. *Journal of Biosocial Science*, 56(3):445-458.

https://doi.org/10.1017/S0021932024000026

Naffaa, V., & Stolfi, A. (2021). Consanguinity and cancer predisposition. *Journal of Community Genetics*, 12(3): 445-452.

Nalls, M.A., Simon-Sanchez, J., Gibbs, J.R., Paisan-Ruiz, C., Bras, J.T., Tanaka, T., *et al.* (2009). Measures of autozygosity in decline: Globalization, urbanization, and its implications for medical genetics. *PLoS Genetics*, 5(3):e1000415.

https://doi.org/10.1371/journal.pgen.1000415

Naqvi, S.F., Yıldız-Bölükbaşı, E., Afzal, M., Nalbant, G., Mumtaz, S., Tolun, A., *et al.* (2023). Homozygous mutations

in thyroid peroxidase (TPO) in hypothyroidism with intellectual disability, developmental delay, and hearing and ocular anomalies in two families: Severe manifestation of untreated TPO-deficiency poses a diagnostic dilemma. *The Yale Journal of Biology and Medicine*, 96(3):347-365.

https://doi.org/10.59249/SSRG6507

National Institute of Population Studies (NIPS), & ICF. (2019). Pakistan Demographic and Health Survey 2017-18. Pakistan: NIPS and ICF.

Nawaz, A., Zaman, M., & Malik, S. (2021). Consanguinity, inbreeding coefficient, fertility and birth-outcome in population of Okara District, Pakistan. *Pakistan Journal of Medical Sciences*, 37(3):770-775.

https://doi.org/10.12669/pjms.37.3.2263

Naz, L., Kamal, A., Kamran, A., & Trueha, K. (2023). Pattern and trends of the total and age-specific fertility rates during 1990-2018 in Pakistan. *BMC Womens Health*, 23:300.

https://doi.org/10.1186/s12905-023-02435-8

Notestein, F.W. (1945). Population-the long view. In: Schultz, T.W., (ed.), Food for the World. Chicago: University of Chicago Press. p36-57.

Ottenheimer, M. (1996). Forbidden Relatives: The American Myth of Cousin Marriage. United States: University of Illinois Press.

Pagano, M., Gauvreau, K., & Mattie, H. (2022). Principles of Biostatistics. 3rd ed. United Kingdom: Chapman and Hall/CRC.

https://doi.org/10.1201/9780429340512

Pakistan Bureau of Statistics. (2017). 6th Population and Housing Census-2017 (Final Results). Available from: https://www.pbs.gov.pk/census-2017-district-wise/results/041 [Last accessed on 2025 Mar 25].

Parsons, T. (1951). The Social System. United States: The Free Press.

Reddy, P.G. (1988). Consanguineous marriages and matrimonial distance: A study among three South Indian caste groups. *Biology and Society*, 5(4):173-178.

Reddy, P.G. (2005). Consanguinity and kinship in India. *Current Anthropology*, 46(2):301-310.

Riaz, H.F., Mannan, S., & Malik, S. (2016). Consanguinity and its sociobiological parameters in Rahim Yar Khan District, Southern Punjab, Pakistan. *Journal of Health, Population and Nutrition*, 35(1):14-19.

https://doi.org/10.1186/s41043-016-0049-x

Rostow, W.W. (1960). The Stages of Economic Growth: A Non-Communist Manifesto. Cambridge: Cambridge University Press.

Sahoo, H., Debnath, P., Mandal, C., Nagarajan, R., & Appunni, S.S. (2021). Changing trends of consanguineous marriages in South India. *Journal of Asian and African Studies*, 56(2):1-15.

https://doi.org/10.1177/0021909621101120

Schellekens, J., Kenan, G., & Hleihel, A. (2017). The decline in consanguineous marriage among Muslims in Israel: The role of education. *Demographic Research*, 37:1933-1948.

https://doi.org/10.4054/DemRes.2017.37.61

Shaw, A. (2001). Kinship, cultural preference, and immigration: Consanguineous marriage among British Pakistanis. *Journal of the Royal Anthropological Institute*, 7(2):315-334.

Shawky, R.M., Elsayed, S.M., Zaki, M.E., Nour El-Din, S.M., & Kamal, F.M. (2011). Consanguinity and its relevance to clinical genetics. *Egyptian Journal of Medical Human Genetics*, 12(2):157-164.

https://doi.org/10.1016/j.ejmhg.2011.07.003

Shenbagam, S., Taylor, A., Jain, R., Fakhro, K., Alkuraya, F., & Tayoun, A.A. (2025). Genetic counseling in the Middle East: Provider perspectives of patient attitudes and cultural challenges. *Human Genomics*, 19:59.

https://doi.org/10.1186/s40246-025-00770-5

Shenk, M.K., Towner, M.C., Voss, E.A., & Alam, N. (2016). Consanguineous marriage, kinship ecology, and market transition. *Current Anthropology*, 57(S13):S167-S180.

https://doi.org/10.1086/685755

Sheridan, E., Wright, J., Small, N., Corry, P.C., Oddie, S., Whibley, C., *et al.* (2013). Risk factors for congenital anomaly in a multiethnic birth cohort: An analysis of the Born in Bradford study. *The Lancet*, 382(9901):1350-1359.

https://doi.org/10.1016/S0140-6736(13)61132-0

Thompson, W.S. (1929). Population. *American Journal of Sociology*, 34(6):959-975.

Tufail, M., Rehman, A.U., & Malik, S. (2017). Determinants of consanguinity and inbreeding coefficient in the multiethnic population of Mardan, Khyber Pakhtunkhwa, Pakistan. *Asian Biomedicine*, 11(6):451-460.

https://doi.org/10.1515/abm-2018-0022

World Bank. (2021). Leveraging Urbanization for Pakistan's Transformation: A Country Environmental Analysis. Vol. 2. Washington, D.C: World Bank Group.

Zaman, M. (2013). Exchange marriages in a community of Pakistan: Adequate social exchange. *The Family Journal*, 22(1):69-77.

https://doi.org/10.1177/1066480713505058