# CONSANGUINITY STUDY IN HOSPITAL POPULATIONS OF PALAKKAD DISTRICT, KERALA II. ROLE OF INFLUENCING FACTORS OF INBREEDING

P. JYOTHILEKSHMI[1]* AND P. M. MATHEW[2]**

[1]Department of Botany, N. S. S. College, Nemmara 678 508

[2]Perakathuseril, Muttada P.O., Thiruvananthapuram 695 025

*For correspondence, Email: jyothi.lp.thanal@gmail.com

## SUMMARY

The role of factors which influence the incidence of consanguinity in the hospital populations of Palakkad district are assessed and evaluated. The major factors are, socio-economic correlates (education, occupation, family income), demographic determinants (year of birth and marriage, spousal age at marriage) and geographic (marital distance, region of residence of spouses). Detailed study was carried out in three groups (Nair, Chetty and Scheduled Castes and Scheduled Tribes) in which the patients abounded in numbers amenable for analysis. The data, by and large, indicated strong influence of the levels of education, occupation, and family income negatively correlated consistently and significantly with rate of inbreeding in all the groups. The data of demographic determinants displayed convincingly declining trend of consanguinity in the younger generation people. Higher rates of related alliance was incident in the low marital distance class in all the groups, while significant negative correlation between inbreeding rate and rural residence evident only in the Nair group.

## INTRODUCTION

Consanguinity or human inbreeding is referred to as the phenomenon of marital union between spouses related to each other by common ancestry. The risk effects of inbreeding arise as a consequence of genetic homozygosis of lethal/semilethal recessive genes resulting in higher frequency of affected homozygous offspring in blood related families (Bittles & Hussain 2000). The level of inbreeding and associated effects in pre-reproductive mortality and morbidity are dependent on a number of genetic and non-genetic factors (Mathew 2017). The non-genetic influencing factors comprise mostly socio-economic co-variables, demographic determinants and geographic factors (Mathew 2018). Many castes and tribals of Kerala State have been practising close-kin marriages for centuries as part of their social custom and tradition. Extensive studies carried out in diverse population groups of the state have yielded

---

**Formerly Professor and Head of the Department of Botany, University of Kerala, Thiruvananthapuram.

evidences suggestive of notable harmful effects with potential implications to consanguinity (Mathew et al. 2006, Mathew & Jyothilekshmi 2017).Consanguinity data are conventionally assembled community-wise by survey method of data collection. However, several studies are known globally, involving inpatients of hospitals, of which many from the Middle East countries, eg. Altunhan et al. (2012), Bener et al. (2009), Shafi et al. (2003) and a few from India including Kerala (Attumelil et al. 2011, Bellad et al. 2012). The present paper concerns the influence and role of major non-genetic influencing correlates like socio-economic (education, occupation, family income), demographic (year of birth, marriage, spousal age at marriage) and geographic (marital distance, place of residence of spouses) on the hospital populations of Palakkad district. Patients belonging to only three groups (Nair, Chetty and  SC-ST) abounded in numbers amenable for analysis, and hence detailed study restricted only to these three groups.

## MATERIALS AND METHODS

Consanguinity data were collected from the patients of three government hospitals in the Palakkad district such as the District Hospital of Palakkad, the Government Hospital for Women and Children, Palakkad, and the Community Health Centre at Nemmara. The District Hospital is one of the multi-specialty hospitals in the district, located at Sultanpet, with 544 beds. The government hospital for Women and Children, with 250 beds, is located near to the District hospital, Palakkad. Nemmara is a rural area, which is the downtown of Nelliampathy Hill Station. The people of  Nemmara and Nelliampathy, who are mainly low-income group farmers and labourers, depend on the Community Health Centre for their hospital service. The Health Centre is provided with 93 beds and five doctors. Consanguinity data were collected using a comprehensive questionnaire which includes a variety of socio-economic, demographic, reproductive and genetic parameters. The data of adult patients were collected directly from them, and of the children, from their bystanders, who are either their parents or close relatives who know the children's families fairly well

The literacy levels of adult patients and children's parents were scored under four classes: (1) primary school, (2) high school, (3) higher secondary school and (4) degree and above. Occupational status was scored under three classes: (1) Low (labourers, marginal farmers, low class employees), (2) Medium (school teachers, middle class farmers and business men, class III and IV employees), and (3) High (class I and II employees, landlords, high business men). For women, a fourth class (housewife) also included. Family income was stratified under four classes: (1) Low (Rs < 12,000/-), (2) Low middle (12,000–60,000/-), (3) Upper middle (60,000–1,20,000/-), and (4) High (> 1,20,000/-). Major demographic determinants were, (1) year of birth considered under five 10 year classes: such as before 1960, 1960-69, 1970-79, 1980-89, and 1990 and above, (2) temporal trend was scored by grouping the year of marriage into five 10 year classes such as before 1970, 1970-79, 1980-89, 1990-99 and 2000 and above, (3) spousal age at marriage of husbands grouped under five classes such as >25, 25–29, 30–34, 35–39 and > 40. Age of women at marriage under five classes: >20, 20–24, 25–29, 30–34, $\geq$ 35. Marital distance was classified into six groups: > 1km, 1–19, 20–39, 40–59, 60–79 and $\geq$ 80 km.

## OBSERVATIONS

The rates of consanguinity in the three groups (Nair, Chetty and SC-ST) by level of education, occupation and family income are furnished in Tables 1, 2 and 3;  those by year of birth,  year of marriage

and spousal age at marriage in Tables 4, 5 and 6, while by marital distance and place of residence of spouses (rural, sub-urban, urban) in Tables 7 and 8.

TABLE 1: Rate of consanguinity by level of education in Nair, Chetty and SC-ST groups.

| Group | Grades of education | | | | Significance |
|---|---|---|---|---|---|
| | Primary school | High school | Higher secondary | Graduation and above | |
| **Husband** | | | | | |
| Nair | 31.52 | 12.33 | 5.15 | 2.91 | ** |
| Chetty | 42.37 | 29.86 | 23.81 | 8.16 | ** |
| SC-ST | 20.45 | 26.82 | 18.9 | 7.32 | ** |
| **Wife** | | | | | |
| Nair | 32.05 | 8.33 | 9.42 | 6.45 | ** |
| Chetty | 36.7 | 29.19 | 25.54 | 15.79 | ** |
| SC-ST | 20 | 27.25 | 4.05 | 0 | ** |

** Significant (p < 0.01).

TABLE 2: Rate of consanguinity by level of occupation in Nair, Chetty and SC-ST groups.

| Group | Levels of occupation | | | | Significance |
|---|---|---|---|---|---|
| | Housewife | Low | Medium | High | |
| **Husband** | | | | | |
| Nair | - | 13.59 | 10.85 | 2.98 | ** |
| Chetty | - | 26.56 | 28.48 | 21.92 | NS |
| SC-ST | - | 22.79 | 4.17 | 12.5 | NS |
| **Wife** | | | | | |
| Nair | 11.78 | 13.06 | 6.38 | 0 | ** |
| Chetty | 30.77 | 26.37 | 19.05 | 0 | NS |
| SC-ST | 19.18 | 23.14 | 15 | 0 | NS |

** Significant (p < 0.01), NS - Not significant.

TABLE 3: Rate of consanguinity by level of family income in Nair, Chetty and SC-ST groups.

| Group | Levels of family income | | | | Significance |
|---|---|---|---|---|---|
| | Low | Low medium | Upper medium | High | |
| Nair | 10.77 | 11.68 | 9.56 | 7.42 | NS |
| Chetty | 32.09 | 24.92 | 28.31 | 23.15 | NS |
| SC-ST | 26.09 | 8.27 | 4.17 | 0 | ** |

** Significant (p < 0.01), NS - Not significant.

TABLE 4: Rate of consanguinity by year of birth of spouses in Nair, Chetty and SC-ST groups.

| Group | Period of birth | | | | | Significance |
|---|---|---|---|---|---|---|
| | < 1960 | 1960−69 | 1970−79 | 1980−89 | >1990 | |
| **Husband** | | | | | | |
| Nair | 13.76 | 12.31 | 13.87 | 5.65 | 5.59 | ** |
| Chetty | 27.43 | 27.4 | 31.97 | 25.73 | 21.21 | NS |
| SC-ST | 28.69 | 28.57 | 23.48 | 9.26 | 3.53 | ** |
| **Wife** | | | | | | |
| Nair | 13.94 | 13.8 | 15.07 | 15.07 | 4.37 | ** |
| Chetty | 28.83 | 32.46 | 28.95 | 23.75 | 22.22 | NS |
| SC-ST | 29.24 | 27.59 | 25.41 | 10.58 | 3.06 | ** |

** Significant ($p < 0.01$), NS - Not significant.

TABLE 5: Rate of consanguinity by year of marriage in Nair, Chetty and SC-ST groups.

| Group | Year of marriage | | | | | Significance |
|---|---|---|---|---|---|---|
| | < 1970 | 70−79 | 80−89 | 90−99 | > 2000 | |
| Nair | 23.04 | 10.87 | 7.88 | 3.52 | 3.48 | ** |
| Chetty | 38.42 | 21.65 | 28.1 | 19.4 | 19.54 | ** |
| SC-ST | 32.23 | 29.11 | 20.22 | 20.17 | 10.76 | ** |

** Significant ($p < 0.01$).

TABLE 6: Rate of consanguinity by age at marriage of spouses in Nair, Chetty and SC-ST groups.

| Group | Age at marriage of spouses | | | | | | Significance |
|---|---|---|---|---|---|---|---|
| | < 20 | < 25 | 25−29 | 30−34 | 35−39 | > 40 | |
| **Husband** | | | | | | | |
| Nair | | 15.68 | 12.9 | 2.95 | 1.14 | 2.13 | ** |
| Chetty | | 45.53 | 36.36 | 15.6 | 1.18 | 2.17 | ** |
| SC-ST | | 34.07 | 33.33 | 18.56 | 8.19 | 0 | ** |
| **Wife** | | | | | | | |
| Nair | 12.67 | 10.91 | 4.63 | 0 | 6.25 | | ** |
| Chetty | 36.05 | 33.21 | 12.36 | 5.55 | 3.03 | | ** |
| SC-ST | 25.13 | 27.44 | 14.7 | 4.65 | 0 | | ** |

** Significant ($p < 0.01$).

TABLE 7: Rate of consanguinity by marital distance in Nair, Chetty and SC-ST groups.

| Group | Distance in kilometers | | | | | | Significance |
|-------|------|---------|-------|-------|-------|------|--------------|
|       | Zero | 1 to 19 | 20−39 | 40−59 | 60−79 | ≥ 80 |              |
| Nair  | 15.27 | 8.75  | 6.4   | 4.3   | 12.5  | 12.16 | **          |
| Chetty | 31.74 | 31.07 | 30.53 | 12.73 | 6.06  | 16.98 | **         |
| SC-ST | 26.84 | 20.62 | 13.22 | 22.86 | 0     | 9.09  | **          |

** Significant (p < 0.01).

TABLE 8: Rate of consanguinity by place of residence in spouses of Nair, Chetty and SC-ST groups.

| Group | Region of residence | | | Significance |
|-------|-------|-----------|-------|--------------|
|       | Rural | Sub-urban | Urban |              |
| Nair  | 14.99 | 10.97     | 3.1   | **           |
| Chetty | 26.02 | 30.38    | 25.52 | NS           |
| SC-ST | 24.72 | 18.89     | 21.95 | NS           |

** Significant (p < 0.01), NS - Not significant.

In all the three groups, the level of consanguinity was lowest in the highest education group, which is highly significant; and literacy is negatively correlated strongly with inbreeding rate (Table 1). In all the three groups, the level of inbreeding was higher in the low occupation class of patients and higher in the low, the correlation being highly significant in the Nairs, and not significant in the other two (Table 2). Correlation between consanguinity rate and family income was significant only in the SC-ST group, and not significant in two others (Table 3). The demographic co-variables by year of birth showed highly significant negative association in both husbands and wives in the Nair and SC-ST groups, which by year of marriage significant in all the three groups (Tables 4 and 5). Association between consanguinity and spousal age at marriage was highly significant negatively in all the three groups (Table 6). Highly significant consanguinity rates evident in marriages involving lower marital distance, consistently in all the three groups (Table 7), while this was so with rural residence only in the Nair group (Table 8), and not significant in the other two.

## DISCUSSION

A vista of non-genetic factors exist influencing consanguineous unions in world population groups, prominent among which are socio-economic co-variables, demographic determinants and geographic factors, in addition to parental inbreeding, size of mating units, linguistic and religious preferences. These may vary from region to region, population to population and caste to caste. Distribution of consanguinity rates across the world shows low rates prevailing in the socio-economically developed

countries and communities, while high rates in the more traditional and rural areas and among illiterate and poor societies (Bittles 2012). Demographic determinants which influence related marriages include year of birth and marriage, spousal age at marriage, birth interval, birth order etc. Economic gains like conservation of property, dowry etc., have been the foremost influencing factors universally. The major influencing factors given emphasis to in the present study of hospital populations of Palakkad district, with special reference to the three groups, Nair, Chetty and SC-ST are, socio-economic, demographic and geographic co-variables.

### Socio-economic factors

Social classes are generally considered and identified in terms of three major socio-economic parameters such as education, occupation and family income.

### Education

Consanguinity studies in world population groups have identified social status as defined in terms of educational level of the people of the community, which has strong influence on the consanguinity rates. In most known studies including the multiplicity of communities of diverse social classes and tribals studied from Kerala , the literacy level is negatively correlated with the consanguinity rates and vice versa (Mathew et al. 2006, Mathew & Jyothilekshmi 2017). The level of education and its bearing on consanguinity rates in the patients belonging to the present three groups was studied by stratifying them under four categories such as Primary, High school, Higher secondary, Degree and above. Strong statistically significant negative correlation between educational levels and consanguinity rates exists in both husbands and wives of the Nair and SC-ST groups, while less significant in the Chetty women (Table 1). Although consistent declining trend of inbreeding exists in the fairly literate societies of the present hospital populations, a clearly opposite trend was reported in another immigrant community, also residing in the Palakkad district (Tamil Brahmin), in which strongly positive association of literacy with consanguinity was evident (Jyothilekshmi 2015). This trend in the community was suggested as due to the Tamil Brahmins residing here having strong tendency to stick on to their original native Tamil custom and tradition in matters of mate selection and kinship ties.

### Occupation

Most known studies aimed at determining the role of occupational level on consanguinity have suggested the practice of close-kin alliances going beyond the social and occupational boundaries (Shami et al. 1991). Studies in many Muslim groups in the Middle East countries demonstrated the occupational status accounting heavily on the association between the levels of occupation and marriages; and the findings revealed occupational level as a relevant indicator of social status (Bittles & Hussain 2000, Khlat 1988). Almost similar pattern of association was evident in communities of different social classes studied earlier from Kerala, in which the tendency often favoured an alliance with a related spouse of equal or better occupational status (Mathew et al. 2006). However, the

association was the other way round in many Scheduled Castes and tribals of the State. In the present Nair group, the rate of inbreeding is low in the high occupation class, in both husbands and wives, and fairly high in the Low and Medium classes, in which highly significant negative correlation exists (Table 2). In the other two groups, although similar trend is apparent, the correlation not significant.

**Family income**

The family income is a major indicator of social status in most population groups. Consanguineous unions have been felt as a feasible choice for many societies to avoid financial liabilities and uncertainties in the Indian scenario (Bittles 2001). In the earlier studies of the Kerala communities, the association between consanguinity rates and family income was assessed by stratifying families under different income groups based on annual family income. A positive association was evident in most communities, especially conspicuous in the Forward and Backward communities (Mathew et al. 2006, Mathew & Jyothilekshmi 2017). The data in most Scheduled Castes and tribals, however, showed clearly negative associations, which in the tribals highly significant. The present hospital data indicated a strong declining trend in the consanguinity rates with decreasing family income in the Nair and SC-ST groups (Table 3), although not significant in the Nair group, while highly significant in the other. In the Chetty group, the declining trend was very marginal and not significant.

**Demographic determinants**

Many studies have established correlation of consanguinity with demographic determinants, which used for interpreting the ascending and descending temporal trends of inbreeding; and most studies have revealed the length of marital life to be directly proportional to the fertility span of women (Bittles & Black 2010). Studies of association of various demographic attributes with consanguinity in the Kerala communities, particularly in terms of year of birth, year of marriage and age at marriage of spouses, revealed a decisive declining trend of preference of related marriages by younger generation people (Mathew et al. 2006, Mathew & Jyothilekshmi 2017). The study in the Kerala communities, surpassing social class difference, revealed higher consanguinity rates in marriages contracted before 1960, which steadily declining down the decades. In the present hospital groups, analysis of rates of inbreeding by year of birth and year of marriage (Tables 4, 5) show consistently higher rates of inbreeding, significantly in older age groups, both in husbands and wives. Assessment of the association of consanguinity with year of marriage is helpful for understanding the time trend of inbreeding. All the three present groups have displayed highly significant declining trend from earlier to recent years. Various reasons have been suggested for the decline from older to the younger people as well as from early to recent periods, which include: (a) awareness about the risk effects of inbreeding among the

younger age group people due to higher literacy and (b) overall increase of socio-economic levels in recent times.

Age at marriage of spouses is demographically important as it determines the length of marital life and fertility span of couples. Many studies have reported incidence of higher rates of close-kin alliances in low age at marriage of spouses, and this was very evident in the Kerala group of communities studied earlier also, which was conspicuously so among the tribal groups (Mathew et al. 2006). In all the present hospital groups, a clear and consistent decline in the rate of related marriage is evident in advanced age at marriage classes, which was highly significant, and strongly so in the women. The low age at marriage, especially of women, provides a longer cohabitation period and extended reproductive span, which facilitates higher fertility profile also.

## Geographic factors

Among the myriad of factors which influence the degree and frequency of related marriages, the geographic ones, especially the marital distance and region of residence of spouses are no less important. People generally select mates from within limited regional boundaries, and hence space and distance between spousal residences become prime determinants of marital unions (Reddy 1983). The known studies have displayed significant negative association between consanguinity rates and marital distance. In all the present three groups, higher rates of related alliances occur in low marital distance classes, and the association is highly significant (Table 7). In all the earlier Indian studies including Kerala, rural residence was convincingly associated significantly with higher inbreeding rates (Hussain & Bittles 2004, Krishnamoorty & Audinarayana 2001, Mathew et al. 2006). Highly significant negative correlation between consanguinity rate and rural residence exist in the present groups only in the Nairs (Table 8), while this in the other two groups only marginal and not significant.

## REFERENCES

ALTUNHAN H, ANNAGUR A, KONAK M, ERTUGRUL S, ORS R & KOC H 2012 The incidence of congenital anomalies associated with cleft palate/cleft lip and palate in neonates in the Konya region Turkey *British J Oral Maxillofac Surg* **50** 541–544

ATTUMALIL T V, SUNDARAM A, VARGHESE V O, VIJAYAKUMAR K & KUNJU P M 2011 Risk factors of childhood epilepsy in Kerala *Ann Indian Acad Neurol* **14** 283–286

BELLAD M B, GOUDAR S S, EDLAVITCH S A, MAHANTSHETTI N S, NAIK V, HEMINGWAY-FODAY J J, GUPTA M, NALINA H R, DERMAN R, MOSS N & KODKANY B S 2012 Consanguinity prematurity birth weight and pregnancy loss: a prospective cohort study at four primary health center areas of Karnataka India *J Perinatol* **32** 431– 437

BENER A, EL AYOUBI H R, CHOUCHANE L, ALI A I, AL-KUBAISI A, AL-SULAITI H & TEEBI A S 2009 Impact of consanguinity on cancer in a highly endogamous population *Asian Pac J Cancer Prev* **10** 35– 40

BITTLES A H 2001 Consanguinity and its relevance in clinical genetics *Clin Genet* **60** 89–98

BITTLES A H 2012 *Consanguinity in context* Cambridge University Press Cambridge

BITTLES A H & BLACK M L 2010 The impact of consanguinity on neonatal and infant health *Early Hum Dev* **86** 737–741

BITTLES A H & HUSSAIN R 2000 An analysis of consanguineous marriages in the Muslim population of India at regional and State levels *Ann Hum Biol* **27** 163–171

HUSSAIN R & BITTLES A H 2004 Assessment of association between consanguinity and fertility in Asian populations *J Health Popul Nutr* **22** 1–12

JYOTHILEKSHMI P 2015 Consanguinity study in the immigrant Tamil Brahmins of Palakkad district Kerala *J Cytol Genet* **16** (NS) 31–37

KHLAT M 1988 Consanguineous marriage and reproduction in Beirut Lebanon *Am J Hum Genet* **43** 188–196

KRISHNAMOORTHY S & AUDINARAYANA N 2001 Trends in consanguinity in South India *J Biosoc Sci* **33** 185 –197

MATHEW P M 2017 Hidden hazards of human inbreeding *J Cytol Genet* **18** (NS) 31–38

MATHEW P M 2018 Socioeconomic correlates and genetic determinants of consanguinity *J Cytol Genet* **19** (NS) 33–39

MATHEW P M, VIJAYAVALLI B & DEVIPRIYA V 2006 Consanguinity and its effects with special reference to inbreeding communities in Kerala *J Cytol Genet* **7** (NS) 185 –195

MATHEW P M & JYOTHILEKSHMI P 2017 *Fundamentals of population genetics with emphasis on human inbreeding* Southern Book Star Thiruvananthapuram

REDDY P C 1983 Consanguinity and inbreeding effects on fertility mortality and morbidity in the Malas of Chittoor district *Z Morph Anthrop* **74** 45–51

SHAFI T, KHAN M R & ATIQ M 2003 Congenital heart disease and associated malformations in children with cleft lip and palate in Pakistan *Br J Plast Surg* **56** 106 –109

SHAMI S A, QAISAR R & BITTLES A H 1991 Consanguinity and adult morbidity in Pakistan *Lancet* **338** 954–955