SUMMARY

1. Consanguinity study has been carried out in fifteen inbreeding castes/communities of the Kanyakumari district (Tamil Nadu state) which include two Forward Communities (Nair and Vellala), eight Backward Communities (Nadar, Vaniyar, Muslim, Viswakarma, Saliyar, Krishnavaka, Yadava and Chetty), two Most Backward Communities (Maruthuvar and Vannan) and two Scheduled Castes (Sambavar and Vetan). Aspects such as pattern and frequency of consanguineous marriages, socio-economic and demographic correlates of related marriages, effects of consanguinity such as couple fertility, pre-reproductive mortality and morbidity, public health impact of inbreeding, effect of long term inbreeding and genetic load in the various communities are discussed.

2. The commonly occurring related marriages in all the communities are first cousin, first cousin once removed and second cousin types. Uncle-niece and double first cousin patterns are the less prevalent types in most of the communities studied. First cross cousin marriages are the commonest of all consanguineous marriages with high preference for the matrilateral cross cousin followed by patrilateral cross cousin subtype. The parallel types of first cousin marriages have not been noticed in any of the fifteen communities.
3. The patterns and frequency of consanguinity and the mean coefficient of inbreeding in respect of the 15 communities are summarised below:

<table>
<thead>
<tr>
<th>Community</th>
<th>U-N</th>
<th>DFC</th>
<th>FC</th>
<th>1.5C</th>
<th>2C</th>
<th>Total</th>
<th>Mean Coefficient of inbreeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nair</td>
<td>0.00</td>
<td>0.19</td>
<td>6.12</td>
<td>0.62</td>
<td>1.57</td>
<td>8.49</td>
<td>0.00116</td>
</tr>
<tr>
<td>Vellala</td>
<td>1.63</td>
<td>0.30</td>
<td>15.50</td>
<td>1.48</td>
<td>4.89</td>
<td>23.80</td>
<td>0.01450</td>
</tr>
<tr>
<td>Nadar</td>
<td>0.00</td>
<td>0.18</td>
<td>14.60</td>
<td>0.58</td>
<td>2.13</td>
<td>17.48</td>
<td>0.01059</td>
</tr>
<tr>
<td>Vaniyar</td>
<td>0.65</td>
<td>0.33</td>
<td>15.36</td>
<td>0.82</td>
<td>3.59</td>
<td>20.75</td>
<td>0.01204</td>
</tr>
<tr>
<td>Muslim</td>
<td>0.00</td>
<td>0.37</td>
<td>21.08</td>
<td>1.59</td>
<td>5.88</td>
<td>28.92</td>
<td>0.01797</td>
</tr>
<tr>
<td>Viswakarma</td>
<td>4.33</td>
<td>0.38</td>
<td>18.08</td>
<td>1.88</td>
<td>5.27</td>
<td>29.94</td>
<td>0.02109</td>
</tr>
<tr>
<td>Saliyar</td>
<td>5.59</td>
<td>1.15</td>
<td>16.91</td>
<td>2.44</td>
<td>8.31</td>
<td>34.40</td>
<td>0.02387</td>
</tr>
<tr>
<td>Krishnavaka</td>
<td>0.00</td>
<td>0.00</td>
<td>27.77</td>
<td>1.13</td>
<td>6.77</td>
<td>35.67</td>
<td>0.01916</td>
</tr>
<tr>
<td>Yadava</td>
<td>9.64</td>
<td>0.38</td>
<td>25.33</td>
<td>1.13</td>
<td>8.32</td>
<td>44.80</td>
<td>0.03117</td>
</tr>
<tr>
<td>Chetty</td>
<td>8.85</td>
<td>0.72</td>
<td>33.97</td>
<td>2.63</td>
<td>7.66</td>
<td>53.83</td>
<td>0.03923</td>
</tr>
<tr>
<td>Maruthuvar</td>
<td>6.27</td>
<td>1.32</td>
<td>23.43</td>
<td>1.65</td>
<td>3.96</td>
<td>36.63</td>
<td>0.02680</td>
</tr>
<tr>
<td>Vannan</td>
<td>5.20</td>
<td>0.00</td>
<td>37.67</td>
<td>0.74</td>
<td>3.96</td>
<td>47.52</td>
<td>0.03075</td>
</tr>
<tr>
<td>Bharathar</td>
<td>4.88</td>
<td>0.78</td>
<td>14.06</td>
<td>1.95</td>
<td>4.49</td>
<td>26.17</td>
<td>0.02000</td>
</tr>
<tr>
<td>Sambavar</td>
<td>0.00</td>
<td>1.05</td>
<td>24.04</td>
<td>0.70</td>
<td>3.83</td>
<td>29.62</td>
<td>0.01794</td>
</tr>
<tr>
<td>Vetan</td>
<td>0.00</td>
<td>1.86</td>
<td>44.19</td>
<td>4.19</td>
<td>6.98</td>
<td>57.20</td>
<td>0.03680</td>
</tr>
</tbody>
</table>

U-N = Uncle-Niece   DFC = Double First Cousin   FC = First Cousin
1.5C = First Cousin once removed   2C = Second Cousin
a) The communities in the present study registered consanguinity rates ranging from 8.49-57.21%, the highest for Vetan and the lowest for Nair community.

b) The mean coefficient of inbreeding correspondingly ranged from 0.00116-0.03923.

c) The distribution of the levels of inbreeding in the 15 communities showed a gradient apparently associated with the level of their social status. Nairs, socially and educationally the most forward group, showed the lowest frequency, while the Vetans, one of the Scheduled Castes with extreme backwardness in social status and literacy level registered the highest rate.

4. Correlation between consanguinity and factors such as literacy level, occupational status, family income, urban-rural difference and time trend in terms of spousal age, age at marriage and period of marriage of spouses were examined in all the communities:

a) There was a negative correlation between education level and consanguinity rate in most of the communities. However, this type of association between the two parameters was highly significant only in the Nair, Nadar, Bharathar and Sambavar communities.

b) High occupational status was found to be associated with low consanguinity rate in all the communities, and the relationship was highly negatively significant in both the spouses in Vannan, Bharathar and Sambavar and women in Nair. No consanguineous marriage was noticed in the high occupational group of Vannan and Sambavar.
c) Families with high income registered low level of inbreeding, but the relationship was highly significant only in Nair, Vaniyar, Yadava, Vannan and Sambavar. In Muslims the income of spouses had no influence on the rate of consanguinity.

d) The data regarding the rate of consanguinity by region showed that there is a decisive urban-rural difference in all the communities except Maruthuvar, Sambavar, Saliyar and Vetan communities.

5. There was a clear and gradual reduction in the rate of inbreeding with increasing marital distance. The difference was highly significant in Nair, Nadar, Saliyar, Sambavar and Vetan communities.

6. Time/Temporal changes of consanguinity levels were analysed for determining the magnitude and direction of time trend.

a) Correlation between the consanguinity rate and period of marriage was analysed separately for all the communities. Most of the communities registered high rate of inbreeding earlier to the 1950's and there was a gradual decline in the subsequent years.

b) Association between spousal age and consanguinity rate was analysed in all the 15 communities, and showed that older age groups exhibited the highest inbreeding rate.

c) The decline of consanguinity rate from early to recent years (1950-1990s) and from older to the younger age groups are due to the effect of socio-economic advancement and increasing literacy.
7. The rate of consanguinity was found to be correlated with lower spousal age at marriage such that lower the age at marriage, especially in women, the higher the rate of consanguinity. There was 100% consanguinity in Vaniyar, Saliyar, Yadava, Maruthuvar and Bharathar among men who married before 20 years.

8. The effects of consanguinity on various parameters like couple fertility, mortality at different stages (prenatal and postnatal) and morbidity were analysed.

a) The mean fertility value ranged from 2.85 to 4.1 in the consanguineous against 2.39 to 3.17 in the nonconsanguineous group.

b) Prenatal mortality was consistently higher in the consanguineous group, which was highly significant in eight communities (Nair, Vellala, Nadar, Vaniyar, Muslim, Chetty, Vannan and Bharathar) and less significant in Saliyar, Krishnavaka, Sambavar and Vetan communities. Analysis by degree of inbreeding showed higher rates for closer degrees of inbreeding.

c) Postnatal mortality rate in all the communities was found to be significantly high. The rate ranged from 5.49% (Sambavar) to 10.20% (Maruthuvar) in the consanguineous group and 1.80% (Vellala) to 5.08% (Chetty) in the control group. Analysis by degree of inbreeding showed positive correlation with closer degrees of relationship such that higher the degree of inbreeding, greater the postnatal mortality.
d) The adverse effect of consanguinity was more conspicuous at postnatal stages than at prenatal in all the communities except Nadar, Yadava and Vannan.

e) Data of incidence of various congenital defects and diseases in different communities showed morbidity risks to be highly significant in the consanguineous families of Nair, Vellala, Nadar, Vaniyar, Muslim, Viswakarma, Saliyar, Krishnavaka, Chetty and Bharathar) and less significant in Yadava and Vannan and insignificant in Sambavar and Vetan. Analysis of Morbidity data by degree of inbreeding showed a consistent positive association between morbidity and closeness of relationship.

9. The Public Health impact of inbreeding on mortality in the different communities has been assessed in terms of (i) Relative Risk (RR) and (ii) Attributable Risk (AR).

a) Among the 15 communities studied the Nairs showed the highest relative risk value for total mortality (3.1250) followed by Vellala (2.6184), and the least for the Krishnavaka (1.4854). In all the cases, the different categories of relative risks such as prenatal (RR\(_1\)), postnatal (RR\(_2\)), and total (RR\(_3\)) mortality showed positive association with the degree of inbreeding such that closer the degree of relationship, higher the mortality risk.

b) The distribution of relative risks (RR\(_3\)) in the 15 communities are recognized under five association categories such as those with (1) Low inbreeding-High mortality (2) Medium inbreeding-Low mortality
(3) Medium inbreeding- High mortality (4) High inbreeding- Low mortality and (5) High inbreeding- High mortality. The data in general indicated that the highest impact of inbreeding in terms of relative risk was exhibited by the Nair community \( (RR_3=3.1250) \) with lowest inbreeding level (8.49%) and the lowest impact of inbreeding (1.6871) in the case of high inbreeding level group represented by Yadava (44.80%) Chetty (53.83%) and Vetan (57.21%) communities.

c) The distribution of relative risks among the five association categories showed that inbreeding and mortality levels are independent events in modifying the levels of relative risks.

d) In the case of the Yadava, Chetty and Vetan communities which belong to the High inbreeding-Low mortality category, the impact of inbreeding is very low which is suggestive that the deleterious genes in them could have undergone significant degree of elimination due to long term effect of inbreeding coupled with very high inbreeding rates occurring in them.

e) Analysis of the relative risks by degree of inbreeding showed consistent positive association between relative risk and the degree of inbreeding.

10. The Attributable Risk (AR) values for total mortality were less than 0.5 in all the communities studied, and this ranged from 0.1370 (Sambavar) to 0.4178 (Vannan). The values of attributable risks in these communities appear to indicate that the related marriages among them could lead to an increase of mortality by 13.70-41.78%. The analysis of the attributable risk by degree of inbreeding showed a consistent positive association between them.
11. All the present communities have been practising related marriages continuously for centuries, and hence it may be expected that some of the deleterious genes could have been eliminated through loss or death of non-viable recessive homozygotes. But the trend of narrowing of differentials of inbreeding effects between the consanguineous and nonconsanguineous groups was not very conspicuously evident in most of the present communities. However, the 'cleaning effect' ascribable to long term inbreeding was apparent in one of the communities (Vetan) in which the 'cleaning effect' could be due to the joint effect of long term inbreeding and high inbreeding rate.

12. The genetic load in the communities have been estimated in terms of A and B statistics, and from this B/A ratio and the number of lethal equivalents/gamete have been computed and estimated.

a) A wide range has been noticed for the values of A (0.0466 in Bharathar to 0.7422 in Vetan) and B (0.9665 in Vetan to 8.5717 in Nadar). In all the communities, the B values were consistently higher than A.

b) The B/A ratio in the communities showed a wide variation ranging from 1.3023 (Vetan) to 160.6882 (Nair). The value was less than 10 in the Vetan community alone, which registered the highest inbreeding rate (57.21%) and the Nair community showed the highest B/A ratio (160.6882) which registered the lowest inbreeding rate (8.49%).
c) It was noticed that in most of the communities studied, the B/A ratio exceeded 10 and the genetic load element in them could be mutational in origin, while in the Vetan community it could be segregational in which the B/A ratio was very low (1.3023).

d) The estimated lethal equivalents/gamete for the different communities were found to lie between 0.5 to 9. The relatively high values (6 - 9) occurred in communities like Nair, Vellala, Nadar and Vaniyar, medium values (3 - 5) in Muslim, Viswakarma, Saliyar, Krishnavaka, Chetty, Maruthuvar and Bharathar and low values (0.5 - 2) in Yadava, Sambavar and Vetan communities.

13. A few proposals for bringing down the consanguinity rates and thereby reducing the associated genetic risks have been suggested. It is necessary that proper genetic counselling should be administered to the inbreeding communities especially to the backward and illiterate ones regarding the empirical risks involved in close-kin marriages.