Index of opportunity for natural selection among the Gowdas of Kodagahalli village, Karnataka, India

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Introduction

It is well-known that demographic variables such as fertility and mortality are the fundamental events of natural selection, which is one of the major evolutionary forces that bring about changes in the genetic make-up of a population over generations. These variables operate singly or jointly to determine the fitness (Darwinian fitness, a demographic property, is a function of fertility and mortality variables of the individuals in a population) of a particular population in a given environment. The intensity of natural selection, which is analytically described by the sensitivity of Darwinian fitness, changes due to age-specific fertility and mortality variables. Many studies revealed that fertility and mortality components are directly responsible for the rate and direction of human evolution. Crow (1958) has shown that the effectiveness of natural selection in a population may be inferred from measures of differential fertility and mortality. He proposed an index known as the index of total selection intensity (I) was found to be moderate taking into consideration the range for many Indian populations. Considering certain differences in fertility and mortality heritable, it appears that natural selection play an important role in shaping the genetic constitution of the Gowda population. Analysis of data indicates that the index due to fertility seems to contribute more towards selection than mortality. This trend might be because of better living condition and health-care system among the Gowdas which have a positive impact on the lower contribution of mortality for the evolution mechanism of the Gowda population through natural selection.

Key words: Fertility, mortality, selection intensity

Materials and Methods

This paper is based on a field survey conducted...
among the Gowdas, one of the major caste populations at Kodagahalli village in Mysore District, Karnataka from the 5th to 25th January 2008. A total number 263 married women were randomly covered under the study. The entire demographic data were collected through in-depth interview using structured schedule following as far as possible the parameters suggested by the World Health Organization (1964 and 1968) and Mahadevan (1986), which includes data on individual records, fertility, mortality and marriage pattern. Data on fertility and mortality were collected through the in-depth interview with each married woman using structured schedules. The fertility and mortality schedule was completed by filling information on the number of conceptions, number of live births, birth order, age, sex and marital status of each offspring, number of dead children, age at death, causes of death, if any, reproductive wastage (abortions and still births).

**Data analysis**

Four important measures on fertility were taken into consideration. These includes child woman ratio, mean number of live births and surviving children to all married women of all ages, completed family size and total fertility rate. For analyzing the data on mortality, three parameters were taken into consideration which includes infant mortality (death before 1 year of life); juvenile (or premature) mortality (death before 15 year of age) and reproductive wastage (abortions and still births).

There are several methods available for estimating fertility and mortality. In the present study, however, the index of total selection intensity was calculated according to Crow’s formula (1958) and the modified method suggested by Johnston and Kensinger (1971). The later took into account of embryonic mortality, but did not analyze post-natal mortality separately. Furthermore, only those mothers who have reached 40 years and above were taken into consideration since fertility declines drastically when a mother reaches 40 years of age. The parameters used in calculating selection intensity are given in Table 1.

The index of selection was separated into two components known as the index due to fertility and index due to mortality. Then the opportunity for selection according to Crow (1958), as well as the modified method suggested by Johnston and Kensinger (1971), was calculated as follows:

**Crow’s index:**

$$I = I_m + (I/P_s)$$

$$I_m = P/P_s$$

$$I = V/(X)^2$$

$$P_s = 1 - P_d$$

where $I$ is the index of total selection intensity; $I_m$ is the index of selection due to mortality; $I$ is the index of selection due to fertility; $P_s$ is the proportion of survivors to birth; $P_d$ is the proportion of pre-matured deaths (i.e., deaths before 15 years of age); $V$ is the variance in the number of life-births due to fertility; $X$ is the mean number of life-births per woman of completed fertility (i.e., ≥40).

**Johnston and Kensinger’s index:**

$$I = I_{me} + I_{mc}/P_b + I/P_s \times P_s$$

$$I_{me} = P_{ed}/P_b$$

$$I_{mc} = P_d/P_s$$

$$P_b = 1 - P_{ed}$$

$$I = V/(X)^2$$

$$P_s = 1 - P_d$$

where $I$ is the index of total selection intensity; $I_{me}$ is the index of selection due to embryonic mortality (pre-natal mortality); $I_{mc}$ is the index of selection due to child mortality; $P_b$ is the proportion of survivors to birth; $P_s$ is the proportion of survivors birth to reproductive age; $P_{ed}$ is the proportion of embryonic deaths; $P_d$ is the proportion of pre-matured deaths (i.e., deaths before 15 years of age); $I$ is the index of selection due to fertility; $V$ is the variance in the number of life-births due to fertility; $X$ is

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**Table 1: Parameters used in calculating selection intensity**

| Parameters | Frequency |
|------------|-----------|
| Number of mothers age 40 years and above | 91 |
| Number of reported pregnancies | 310 |
| Number of live births | 277 |
| Number of surviving children | 253 |
| Number of deaths before 15 years | 40 |
| Number of embryonic deaths | 47 |
| Proportion of survivors to birth (Pb) | 0.7486 |
| Proportion of child death (i.e. deaths before 15 years) (Pd) | 0.1444 |
| Proportion of embryonic deaths (Ped) | 0.1516 |
| Mean number of live-birth per mother aged 40+ years (X) | 3.0439 |
| Variance (V) | 2.465 |
the mean number of live-births per woman of completed fertility (i.e., ≥40).

**Results and Discussion**

Data on fertility and mortality of the present population are given in Table 2. These data are presented mainly because both fertility and mortality variables are important in determining the selection intensity of the present population. Table 1 shows that there were 91 mothers aged 40 years and above. The mean number of live births to such mothers was found to be 3.0439 with the corresponding variance of 2.465. The proportion of child mortality before reproductive age and the proportion of embryonic deaths was 0.1444 and 0.1516 respectively. In order to understand how selection is operating in this population, the index of opportunity for selection was calculated by considering that certain differences in fertility and mortality are heritable. It was found that the value of $I$, $I_f$, and $I_m$, calculated according to Crow's formula (1958) was 0.4795, 0.2660 and 0.1687, respectively. On the other hand, the index of total selection intensity calculated according to Johnston and Kensinger (1971) was 0.2025, 0.1687, 0.2660 and 0.6553 respectively [Table 3]. Therefore, the total selection intensity ($I$) calculated according to Crow's formula was lower than that calculated according to Johnston and Kensinger. This may be due to the fact that in the case of Crow's formula, we have not taken into consideration the embryonic deaths (still-births and abortions) as done in the case of Johnston and Kensinger's formula. However, considering both the methods, the index due to fertility seems to contribute more toward selection than the index due to mortality. In other words, the Gowda population seems to be evolving more through the mechanism of fertility rather than mortality.

These findings depict a number of possible reasons. Fertility and mortality performance of a population depends largely on various bio-social events. Cavalli-Sforza and Bodmer (1971) reported that among most agrarian and tribal societies, mortality contributes more towards selection rather than fertility. Similarly, studies on Indian populations indicate that deaths prior to pre-reproduction age contribute more to the process of natural selection. These fluctuations may be due to varied reasons like differences in mean live-births, which is inversely proportional to selection intensity. But in the present study, as per Crow's formula the index due to fertility (0.2660) was found to be higher than that of mortality (0.1687). This indicates that the better living condition and health care system might be responsible for lower contribution of mortality. Rajanikumari et al. (1985) reported that in the majority of Andhra caste populations, fertility contribute

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**Table 2: Fertility and mortality data following parameters suggested by WHO (1964 and 1968), Mahadevan (1986)**

| Parameters                                      | Frequency |
|-------------------------------------------------|-----------|
| Mean age at marriage±SE (years)                 | 25.76±0.32|
| Mean age at 1st child birth±SE (years)          | 27.71±0.30|
| Fertility ratio/100 women                       | 18.18     |
| Complete family size                            | 3.27±0.21 |
| Mean no. of live births/mother±SE               | 2.25±0.08 |
| Mean no. of surviving children/mother±SE        | 2.13±0.07 |
| TFR: Total fertility rate, SE: Standard error, WHO: World health organization |

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more than mortality towards selection. In this population too, the same trend happen in which the lower contribution of mortality to fertility was due to better living condition and health care system. It is important to be noted that the Gowdas of Kodagahalli comprises the majority of the population in the village. The village is not very far from Bannur town (approximately 15 km) as well as from the district headquarter Mysore city (35 km), where good facilities to medical as well as to education are available. Regular vehicle services as well as good transport conditions make people more accessible to these places.

Further, in the present study, only those mothers who have reached 40 years and above were taken into consideration since fertility declines drastically when a mother reaches 40 years of age,[16-18] in which the same trend has been observed here. It is important to note that Reddy and Chopra (1990),[21] have compiled the results on the indices of selection calculated according to Crow’s formula (1958),[6] on 96 Indian populations and reported that the mean value of the total index of selection in these populations was 0.665 with a standard deviation of 0.316. According to Khongsdier (2000),[22] if the value of Crow’s index of total selection intensity falls <0.340; 0.340-0.470; 0.470-0.600; 0.600-0.730; 0.730-0.860; and >0.860 for Indian populations, then it may be classified as low, moderate, mild, average, high and very high respectively. Therefore, following this classification, it indicates that the opportunity for natural selection to operate in this population is moderate, taking into consideration the range for many Indian populations.

In comparison with some related findings from other SI populations [Table 4], the total index of selection (according to Crow [1958]),[6] of the present population (0.47) was found to be similar to that of the other SI populations, but lower to that of the Chenchu population (1.45). With respect to the index due to fertility, the Gowdas (0.26) seem to have a similar trend with the Brahmin (0.20) though it was slightly lower than that of the other SI populations. Similarly, index due to mortality (0.16) appears to be similar to that of the Brahmin (0.13) though it was lower in comparison to other SI populations.

Nevertheless, this result indicates the importance of natural selection in influencing the genetic variation of the present population because if the index of total selection intensity comes to zero, there will be no change in the genetic make-up of a population through selection.[1] No doubt, further research is required to throw more light on what has been pointed here in connection with the contribution of fertility and mortality indices toward evolutionary pattern of this population through natural selection.

**Conclusion**

From an evolutionary point of view, selection plays a major impact in bringing changes in the genetic make-up within the Gowda population of Kodagahalli village. It appears that selection is operating with moderate intensity and contributes more through differential fertility than mortality. This trend might be because of better living condition and health-care system among the Gowdas, which have a positive impact on the lower contribution of mortality for the evolution mechanism through natural selection.

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