

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

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BACKGROUND: In order to understand how selection is operating in the Gowda population, the index of opportunity for selection was calculated and the present findings were compared with some related findings from other South Indian (SI) populations.

MATERIALS AND METHODS: Crow (1958) and the modified method by Johnston and Kensinger (1971) were used for the present purpose.

RESULTS AND DISCUSSION: 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

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 operates 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.^[1] The intensity of natural selection, which is analytically described by the sensitivity of Darwinian fitness, changes due to age-specific fertility and mortality variables.^[2] Many studies revealed that fertility and mortality components are directly responsible for the rate and direction of human evolution.^[3-5] Crow (1958),^[6] 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 (now the index of opportunity for selection), taking into account the differential fertility and mortality. This index measures the proportion by which fitness would increase with specific birth and death rates if they all selective and heritable of fitness were complete. Later, Johnston and Kensinger (1971),^[7] devised a modified form of this, which took into account of embryonic mortality, but did not analyze post-natal mortality separately.

The purpose of the present study is to estimate the index of selection intensity (opportunity for selection) in the Gowda caste population according to Crow's formula (1958)^[6] and the modified method suggested by Johnston and Kensinger (1971)^[7] and also to compare the present findings with some related findings from other South Indian (SI) populations.

Materials and Methods

This paper is based on a field survey conducted

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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)^[8,9] and Mahadevan (1986),^[10] 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.^[11-15] In the present study, however, the index of total selection intensity was calculated according to Crow's formula (1958)^[6] and the modified method suggested by Johnston and Kensinger (1971).^[7] 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.^[16-18] 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

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 (P_b)	0.7486
Proportion of child death (i.e. deaths before 15 years) P_d	0.1444
Proportion of embryonic deaths (P_{ed})	0.1516
Mean number of live-birth per mother aged 40+years (\bar{X})	3.0439
Variance (V_f)	2.465

index due to mortality. Then the opportunity for selection according to Crow (1958),^[6] as well as the modified method suggested by Johnston and Kensinger (1971),^[7] was calculated as follows:

Crow's index:

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

$$I_m = P_d/P_s$$

$$I_f = V_f/(\bar{X})^2$$

$$P_s = 1 - P_d$$

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

Johnston and Kensinger's index:

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

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

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

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

$$I_f = V_f/(\bar{X})^2$$

$$P_s = 1 - P_d$$

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_f is the index of selection due to fertility; V_f is the variance in the number of life-births due to fertility; \bar{X} is

the mean number of life-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),^[6] 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),^[7] viz., I_{me} , I_{mc} , I_f and I 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.^[7] 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.^[7] 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),^[19] 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)^[20] reported that in the majority of Andhra caste populations, fertility contribute

Table 2: Fertility and mortality data following parameters suggested by WHO (1964 and 1968),^[8,9] and Mahadevan (1986),^[10]

		Fertility					TFR	
Mean age at marriage±SE (years)	Mean age at 1 st child birth±SE (years)	Fertility ratio/100 women	Complete family size		Mean no. of live births/mother of present age groups±SE	Mean no. of surviving children/mother of present age groups±SE		
			Mean no. of live births/mother±SE	Mean no. of surviving children/mother±SE				
Male	25.76±0.32	27.71±0.30	18.18	3.27±0.21	3.05±0.20	2.25±0.08	2.13±0.07	3.13
Female	17.39±0.23	19.41±0.23						

Mortality (infant, juvenile and reproductive wastages)		Frequency
Parameters		
Total number of mothers		263
Total number of pregnancies		647
Total number of live births		593
Total number of deaths before 1 year of age		33
Total number of deaths (between 1 and 14 years of age)		4
Total number of abortion		15
Total number of still births		32
Total number of reproductive wastage		47
Death before 1 year of age (%)		5.56
Death between 1 and 14 years of age (%)		0.67
Abortion (%)		2.32
Still birth (%)		4.95
Reproductive wastage (%)		7.26

TFR: Total fertility rate, SE: Standard error, WHO: World health organization

Table 3: Indices of selection intensity

According to Crow (1958) ^[6]			According to Johnston and Kensinger (1971) ^[7]			
I_m	I_f	I	I_{me}	I_{mc}	I_f	I
0.1687	0.2660	0.4795	0.2025	0.1687	0.2660	0.6553

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

Table 4: Indices of selection intensity among South Indian populations

Population	Crow's index (1958) ^[6]			Source
	I_m	I_f	I	
Gowda	0.16	0.26	0.47	Present study
Palle	0.44	0.50	0.94	Reddy and Chopra, 1990 ^[21]
Vada	0.35	0.34	0.69	Reddy and Chopra, 1990 ^[21]
Chenchu	0.46	0.96	1.45	Sirajuddin, 1984 ^[23]
Brahmin	0.13	0.20	0.33	Rajanikumari, <i>et al.</i> , 1985 ^[20]

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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