Selection intensity and its opportunity among Santal women of Keonjhar, Odisha, India

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Abstract

The present study dealt with the opportunity of natural selection using Crow's index and Johnston and Kensinger's Index among Santal women of Keonjhar, Odisha, India. Mortality index (I_m), Fertility index (I_f) and Total Selection Intensity index (I) were analyzed among the studied population. The Crow's total index (I_t) value was found to be 0.7246. The mortality (I_m) component was found to be 0.5385 while the fertility (I_f) component was found to be 0.1846. The contribution of fertility component is greater than that of mortality component among the present studied population using Crow's index. According to Johnston and Kesinger the total index (I_t) was found to be 0.8367. Fertility component was found to be 0.0885, Prenatal mortality component (I_{me}) and Postnatal mortality component (I_{me}/P_b) where observed to be 0.1356 and 0.1540, respectively. Therefore, it is clear from the results that prenatal mortality contributes higher than postnatal mortality for selection. i.e., Johnston and Kesinger's Index (0.8367) contributes higher for the opportunity of natural selection than Crow's Index (0.7246).

Keywords: **S**election, **f**ertility, mortality, tribe, prenatal, postnatal.

1. Introduction

Natural selection is one of the principal driving forces of modern biology and adaptive evolution. The term was introduced by Darwin in his book "On the Origin of Species", in 1859[1]. Scientists define "natural selection" specifically as "those mechanisms that contribute to the selection of individuals that reproduce", without regard to whether the basis of the selection is heritable[2,3]. With the enhancement of overall facilities related to health, contemporary world is passing through demographic transitions and it has been characterized by reduction in mortality and fertility[4]. Anthropologists and sociologists viewed demographic transitions as an evolutionary puzzle, as it seems to breach the instinctive wisdom that developed ecological conditions should enhance fertility rate[5]. Intra-species competition among individuals for sexual partners cause diversified fitness; it is an essential condition of natural selection to operate evolution[6]. Mating system in any

population can strengthen the sexual selection. Sexual selection is generated by the high rate of polygamy (polygyny)[7,8]. Fertility and mortality define selection intensity of a group and therefore degree of differences in fertility and mortality is used to determine the fitness of a population[9]. Differential DNA replication is used as direct estimate of natural selection in the context of the ecology where an individual survive, breed and flourish, but due to the extended life span of human it is complicated[10]. In any population natural selection takes place only when variability of this fitness is present. Reproductive success in humans depend upon the total number of progeny that parents contribute to the next generation[11].

Thus, Crow [10] devised an indirect method, a composite index involving fertility and mortality parameters for postnatal life and which was later on improvised by Johnston and Kensinger[12] to measure the maximum potential rate for prenatal life

of change through differential mortality and fertility. There was several factors viz., social, cultural, religious, ethnic, biogenetics and environmental that leads to differential fertility and mortality among the populations[13]. Different studies conducted by scholars in this area of research worldwide including India have investigated the influence of social and cultural factors on overall selection intensity[14-25]. Hitherto, very limited studies have been conducted among the Schedule tribes of Eastern India. Therefore, the present study aims to reveal the opportunity for natural selection, affective population size and variation in reproductive success among the Santals of Harichandrapur reserved forest area of Keonjhar District, Odisha, India.

2. Materials and Methods

The data for the present research was collected by (BK) during 2013, in the village Golabandha, Harichandrapur block, Keonjhar district, Odisha. Demographic data were collected from 90 ever married Santal women on fertility (pregnancies, live birth, no. of children etc.) and mortality (still birth, child death before 15 years of age etc.). Keonjhar district lies between 23 1' North to 23 10' North latitude and 86 11' East to 86 23' East longitude[26]. Keonjhar is situated 175 km from Cuttack, a major town of Odisha, India. Out of the total 41,947,358 population of Odisha, 22.13 % of the population belongs to scheduled tribes [27]. Santals belong to the Proto-Australoid group with dark skin colour, sunken nose and lower forehead. It comprises 1.5% of the total tribal population of Odisha[27]. All the data were collected after obtaining the needed approval from the block and village authorities. Ethical clearance was obtained from the appropriate authorities prior to the commencement of the study. Women were informed about the objectives of our study before the collection of data. The collected data included age, ethnicity, sex; the fertility and mortality rates at both prenatal (total conception, abortions, and stillbirths) and postnatal stages, using a pre-tested structured schedule by house-to-house visit following interview. Opportunity for natural selection was computed using internationally accepted indirect method of postnatal[10] and modified formula of Johnston and Kensinger[12]:

Crow's Index

$I = I_m + I_f / P_s$

$I_m = P_d / P_s$

$P_s = 1 - P_d$

$I_f = V_f / X^2$

Where, I = Index of total selection intensity.

I_m = Index of selection due to mortality

P_d = Probability of deaths up to Pre-reproductive age

P_s = Probability of survival up to reproductive age

I_f = Index of selection due to fertility

V = Variance due to fertility

X = Mean number of live births

Johnston and Kensinger's Index

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

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

$P_b = 1 P_{ed}$

$I_{mc} = P_d / P_s$

$P_s = 1 P_d$

$I_f = V / X^2$

Where; I = index of total selection intensity

I_{me} = index of total selection due to prenatal mortality

P_{ed} = probability to die before birth

P_b = probability to survive till birth

I_{mc} = index of total selection due to postnatal mortality

P_d = probability to die before reaching reproductive age

P_s = probability to survive till reproductive age

I_f = index of total selection due to fertility

V = variance due to fertility

X^2 = mean number of children per women

3. Results and Discussion

The parameters used in calculating the total selection intensity in the study tribal population are presented in Table 1. It is clear from table that the average live birth per mother (X) of 40 Years and above is 2.87 whereas the frequency of premature death (P_d) (those individuals died before 15 years of age) is 0.35.

Table 2 shows the values of the selection intensity indices. The Crow's total index value of the Santal tribe of Golabandha village, Odisha was found to be 0.7246. The mortality component was 0.5385 while the fertility component was found to be 0.1846. The percentage of the fertility component was observed to be 90.70 % while the percentage of mortality component was 9.30 %. Therefore, in total index (I_t) the contribution of fertility component is greater than that of mortality component among Santal tribal population. Johnston and Kesinger[12] have provided the modified formula. According to this modified formula the total index (I_t) was found to be 0.8367. Fertility component was found to be 0.0885, Prenatal mortality component (I_{me}) and Postnatal mortality component (I_{me}/P_b) where observed to be 0.1356 and 0.1540, respectively. For total index (I_t) of 0.8367, the percentage of fertility component (79.55 %) exceeds the percentage prenatal mortality component (12.34 %). Therefore, it

is clear from the results that prenatal mortality contributes higher than that of postnatal mortality for selection. i.e., Johnston and Kesinger's Index (0.8367) contributes higher for the opportunity of natural selection than Crow's Index (0.7246).

Findings of the present studied population shows that for total index (I_t) the contribution of fertility component is more in selection process (90.70 %) than that of mortality component (9.30 %). The high pre natal mortality in this studied community may be due to the poor health and nutritional status and inadequate prenatal medical facilities available to them due to their low socio-economic condition. There were various factors responsible for child mortality but it greatly depends upon social status of the family and community, lower the status, higher will be the incidence of mortality[28]. Results were also compared (Table 3) using Crow's index values with other available results of fertility and mortality rate among different tribal women of India in their reproductive age's shows disparity with respect to their reproductive success and biological status for natural selection.

Table 3 also shows the State wise comparison of mean live birth, mortality Component (I_m), fertility Component (I_f) and total index (I_t) of the studied tribal women of India. It is evident that the highest number of live birth per mother of 40 Years and above has been observed among the Jaintias of Assam (8.10)[29] and lowest among the Sankar Koch of Meghalaya (2.25)[30]. Highest mortality Component (I_m) was found among Pardhans of Andhra Pradesh (0.802) (Murthy and Ramesh, 1978) and lowest among Baiga tribe (0.077) of Madhya Pradesh[31]. The fertility component (I_f) was observed to be highest among Kota I (0.815) of Tamilnadu [32] and lowest among Bhoska (0.058) of Uttar Pradesh [33]. It is also clear that total index (I_t) was highest among Kota I of Tamilnadu (2.250)[32] and lowest among Mina's of Rajasthan (0.265)[34]. While taking percentage of Fertility component, Santals of West Bengal (80.1)[34] had the highest and Bhoska of Uttar Pradesh (20.8)[33] had the lowest . On the other hand percentage of mortality component showed that Bhoska of Uttar Pradesh (79.2) Garg *et.al.*[33] had the highest value and Santal's of West Bengal (19.9)[34] had the least.

Table 1: Parameters used for calculating the total selection intensity among Santals of Golabandha village, Odisha, India

Parameter	Santal
Number of women aged 40 years and above	90
Number of reported pregnancies	296
Number of, live births	258
Number of survivors children	234
Proportion of survivors to births (P_b)	0.8805
Proportion of child birth i.e. death before 15 Years of age (P_d)	0.35
Proportion of embryonic death (P_{ed})	0.1194
Mean number of live birth per mother of 40 Years and above (X)	2.87
Total breeding population size (N)	293
Effective population size(N_e)	371
Number of male aged between 18-59 years	138
Number of female aged between 15-45 years	155
Total population size	496

Table 2: Selection Intensity Index among Santals of Golabandha village, Odisha, India

Selection Component	Values of Santal
Crow's Index	
Mortality Component (I_m)	0.5385
Fertility Component (I_f/P_s)	0.1846
Total Index (I_t)	0.7246
% of fertility component	90.70
% of mortality component	09.30
Johnston and Kesinger's Index	
Prenatal mortality component (I_{me})	0.1356
Postnatal mortality component (I_{me}/P_b)	0.1540
Fertility component ($I_f/P_b.P_s$)	0.0885
Total Index (I_t)	0.8367
% of fertility component	79.55
% of prenatal mortality component	12.34
% of postnatal mortality component	08.11

Table 3: State wise comparative table showing Indices of selection intensity among the studied tribes of India

Studied Tribes	No. Mothers	Mean live births	According to Crow (1958)			References
			I_m	I_f	I	
Andhra Pradesh						
Chenchu	146	5.70	0.500	0.200	0.810	Sirajuddin & Basu, [35]
Hill Kolam	104	5.81	0.348	0.284	0.728	
Kolam	229	5.65	0.443	0.295	0.870	
Manne Kolam	125	5.51	0.540	0.306	1.012	Murthy & Ramesh, [36]
Pardhans	28	6.18	0.802	0.222	1.186	
Raj Gonds	52	4.52	0.346	0.287	0.724	
Sugalis	73	6.08	0.375	0.162	0.606	Reddy & Reddy, [37]
Khond	41	3.68	0.324	0.372	0.613	Rao *et al*[38]
Apathani Guchi	120	5.43	0.440	0.312	0.889	Padmanabham, [39]
Singapos	143	5.17	0.437	0.406	1.020	Padmanabham, [40]
Gadaba	269	3.39	0.160	0.147	0.331	Bharathi[41]
Savara	167	3.48	0.194	0.154	0.378	
Assam						
Jaintias	39	8.10	0.456	0.125	0.638	Deka[29]
Sonowai Kachari	200	7.04	0.192	0.141	0.360	
Gujarat						
Naika	49	5.71	0.305	0.135	0.481	Padmanabham[42]
Himachal Pradesh						
Kinnaura	160	4.89	0.194	0.159	0.384	Gautam *et al*[43]
Jammu & Kashmir						
Tibetan	92	4.2	0.142	0.324	0.512	Kapoor *et al*[44]
Bodh	122	4.58	0.114	0.244	0.386	
Madhya Pradesh						
Baiga	111	5.16	0.077	0.249	0.345	Gautam *et al*[31]
Gond	59	4.42	0.125	0.253	0.409	
Meghalaya						
Hajongs	51	6.80	0.443	0.131	0.631	Barua[13]
Sankar Koch	23	2.25	0.262	0.070	0.531	Kotal & Sengupta[30]
Mizoram						
Hmar	132	7.48	0.085	0.250	0.357	Varte & Varte[45]
Odisha						
Bhuiyan	71	2.69	0.587	0.190	0.7804	Kuiti & Bose, [46]
Santal	90	2.87	0.539	0.185	0.725	Present study
Rajasthan						
Sahariya	72	4.28	0.145	0.212	0.388	
Mina	80	5.21	0.104	0.146	0.265	Kapoor & Kshatriya [34]
Bhil	88	5.27	0.105	0.203	0.329	
Tamilnadu						
Irula	279	5.03	0.327	0.370	0.818	Reddy [47]
Kota I	120	4.10	0.790	0.815	2.250	Basu, [32]
Kota II	328	3.73	0.445	0.638	1.367	Ghosh[48]
Uttar Pradesh						
Bhoska	30	6.45	0.282	0.058	0.356	Garg et.al.1980 [33]
Uttaranchal						
Barbatiya	54	3.89	0.243	0.443	0.794	
Buthalia Bora	118	4.79	0.148	0.226	0.407	Kapoor et.al.[44]
Harkotiya	113	4.58	0.223	0.330	0.627	
Rajput	62	5.26	0.148	0.263	0.450	
West Bengal						
Pahira (North)	39	4.97	0.815	0.175	1.133	
Pahira (Southern I)	50	5.44	0.529	0.137	0.738	Basu[49]
Pahira (Southern II)	50	5.70	0.484	0.137	0.687	
Toto	40	7.63	0.320	0.100	0.550	Debnath & Sen[50]
Munda	31	5.23	0.132	0.166	0.320	
Santal	64	3.97	0.081	0.302	0.407	Kapoor & Khatriya[34]
Lodha	74	4.19	0.157	0.292	0.459	

Figure 1 (a & b): Comparison of fertility component (%) of tribes of 14 States of India.
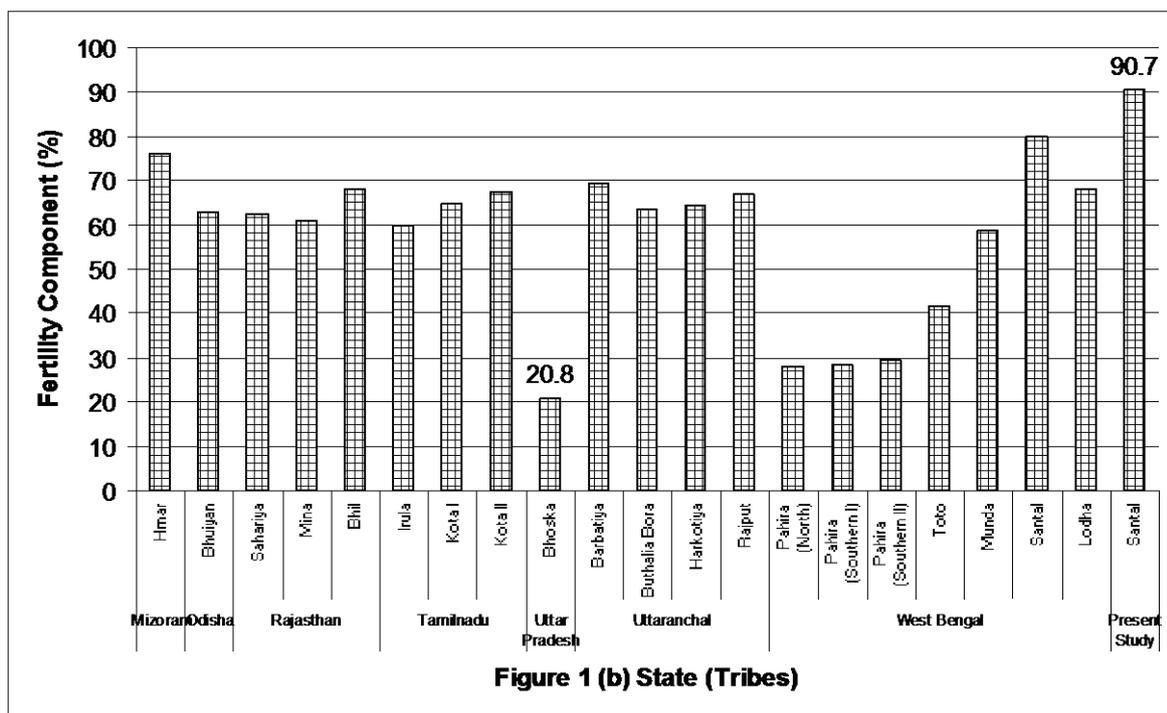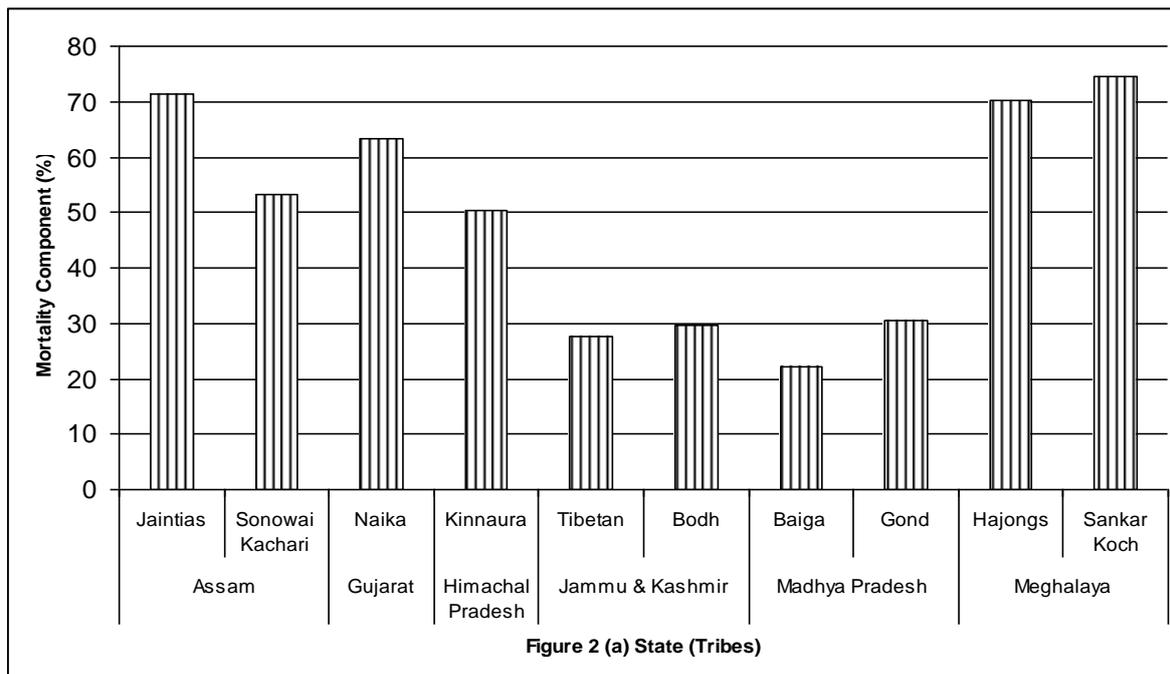

Figure 1 (a) State (Tribes)

Figure 1 (b) State (Tribes)
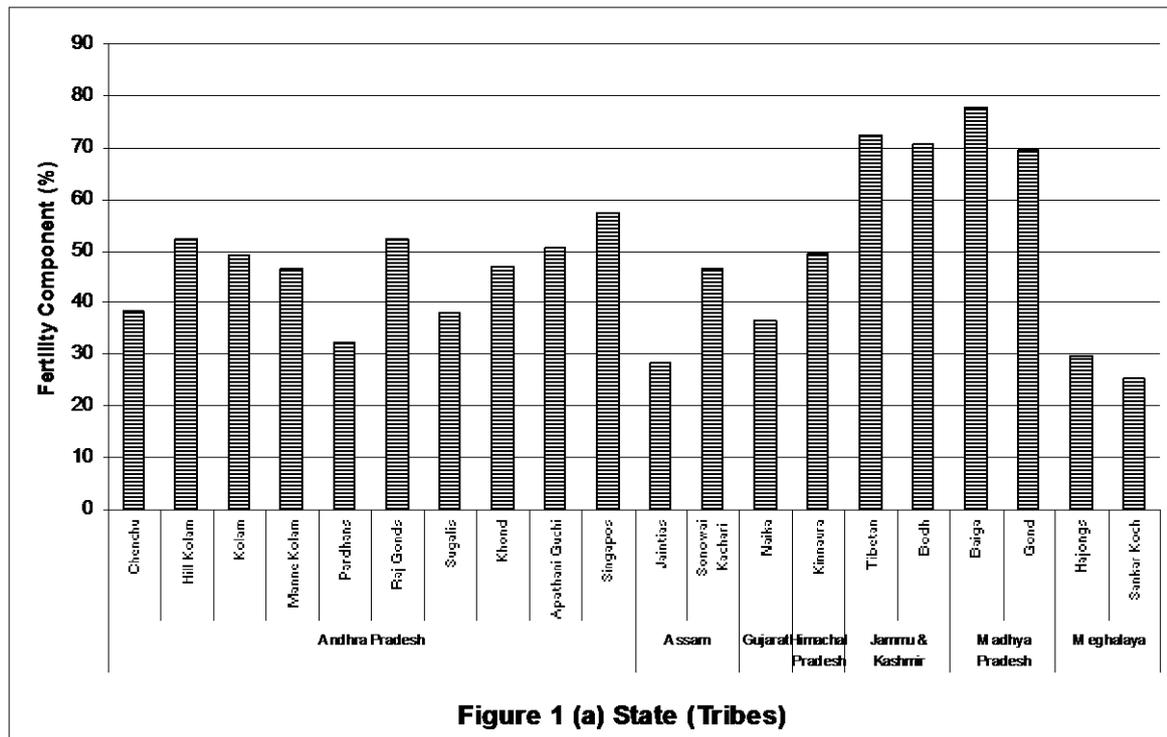
Figure 2 (a & b): Comparison of mortality component (%) of tribes of 14 States of India.

Figure 2 (a) State (Tribes)

Figure 2 (b) State (Tribes)
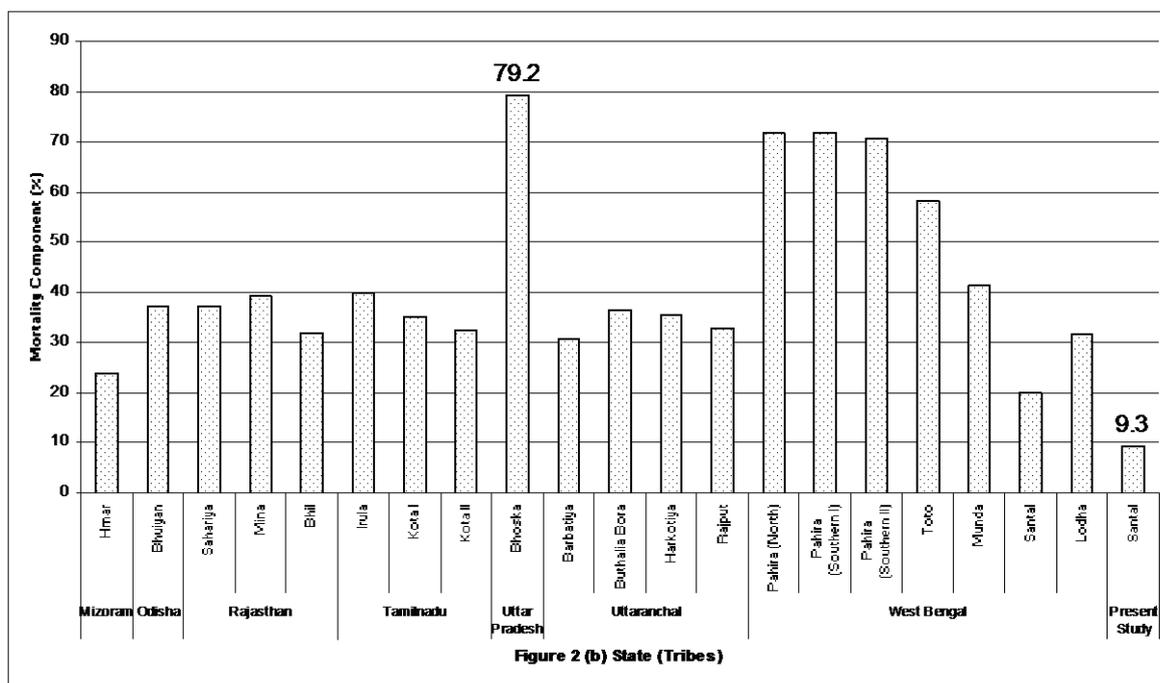
4. Conclusion

It has been concluded that on an average mortality index (I_m) is relatively higher as compared to the overall fertility index (I_f) among the present study population. Marked decline in the mortality index has been observed in general population in our country due to the better socio-economic development in last few decades, but on the other hand underprivileged section (tribal's) are still facing the problems of booming in their number due to health factor and other living conditions. Thus, health related awareness programme should be organized among such populations under consideration to overcome with reproduction related problems.

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Declaration of interest

The authors report no conflict of interests.

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