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Selection intensity of two Santal groups exposed to different environmental conditions of Birbhum district, West Bengal

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ABSTRACT

Selection intensity of human populations has been extensively studied. But, effect of environmental exposure on selection intensity is yet to be studied. Thus, an attempt has been made to investigate the selection intensity of two Santal groups having similar socio-economic and geo-climatic condition but exposed to different environmental condition of Birbhum district, West Bengal.

Data on fertility and mortality have been collected with the help of a well tested questionnaire/schedule from total 138 (affected group = 82, control group = 56) ever-married post-reproductive (i.e. age ≥45 years) women. Here, women of affected group were exposed to stone dust, noise and other environmental hazards as due to their settlement and occupation in the stone quarries and crushers. On the other, individuals of control group were free from those exposures as they were living far away from stone quarries and crushers and engaged in household work and agricultural activities. Both Crow's (1958) as well as Johnston and Kensinger's (1971) indices were applied for calculating selection intensity.

Exposure to stone dusts, noise and other environmental hazards has markedly influenced the selection intensity and some selected demographic events in affected group. Selection intensity index was low in affected group compared to control group. That indicates individuals of affected group are less selected to their respective environment than individuals of control group, which is relatively free from all those hazards.

Key words: *Selection intensity, environmental exposure, fertility, mortality, Santal*

INTRODUCTION:

Fertility and mortality are two important demographic events generally used to determine the structure and fitness (sometimes referred as Darwinian fitness) of population living in a particular environment. Differences in these two events contribute and indicate the intensity of selection, which is the major force behind evolution.

However, it is difficult to measure and interpret the actual mechanism of selection, directly from human population, because it usually requires very large sample size (Morton, 1968; Jorde & Durbize, 1986). In 1958, Crow devised an index (Crow, 1958) which is the most feasible means of studying selection indirectly. On the basis of differential fertility and mortality it measures the fitness of human population, and assumes both birth and deaths are controlled by genetic factors and heritability of fitness was complete (Crow, 1972). Small value of the selection intensity index indicates little fitness, whereas larger value indicates greater fitness of the population (Downhower *et al.*, 1987). Later the index (i.e. Crow's index) was modified by other scholars and added further dimensions of mortality (Johnston & Kensinger, 1978; Basu *et al.*, 1988; Sikdar, 2012).

Selection intensity of human populations has been extensively studied throughout the world including India and have noted variation of selection intensity with regards to economic condition (Frisancho *et al.*, 1976; Bharati, 1981; Sikdar, 2012), cultural practices (Sphuler, 1962; Livingstone & Sphuler, 1965; Johnston & Kensinger, 1978; Mukhopadhyay, 1982; Sengupta & Begum, 1998), education and social status (Reddy & Chopra, 1990; Kapoor *et al.*, 2003; Das & Sikdar, 2010) and altitudes (Cruz-Coke *et al.*, 1977; Gupta, 1980; Kapoor *et al.*, 2003; Gautam *et al.*, 2009).

While other studies suggested variation in selection intensity between migratory and settled groups (Kapoor & Patra, 1998; Sarma, 2013), rural-urban population (Sengupta & Chakravarty, 1998; Dharanipriya et al, 2003; Kar *et al.*, 2007; Sikdar, 2008), ethnic groups/ sub-groups of the same population (Roy & Bharati, 1982, Kapoor *et al.*, 2001; Lakshmi *et al.*, 2005). However, the studies on the effect of environmental exposure on selection intensity are very scanty.

Therefore, objective of the present study is to investigate the selection intensity of two Santal groups, having similar socio-economic and geo-climatic condition but exposed to different environmental condition of Birbhum district, West Bengal.

MATERIAL & METHODS:

Population and Study area:

Present data is a part of an ongoing bio-medical project on health of the stone quarry workers of Birbhum district, West Bengal. Data have been collected from two differently exposed

Santal groups of Birbhum district, West Bengal. Individuals of affected group were the permanent settler of Md. Bazar police station where stone quarries and crushers were abundant. Most of the adult individuals of affected group were dependent on the work of stone industry. On the other, individuals of control group were residing far away from the stone quarry and crusher under Suri police station area where people were mostly engaged in household work followed by agricultural activities, collection of forest products etc. So, it is intuitively understood that individuals of affected group were more exposed to environmental hazards like stone dust, noise etc. created during the process of quarrying and crushing of stones. Prolonged exposure to such environment may have some adverse effect on the health as well as on some demographic events of the population.

Data on fertility and mortality including number of pregnancies, live births, age at death have been collected with the help of a well tested questionnaire/schedule from total 138 (affected group = 82, control group = 56) ever-married post-reproductive (i.e. age $\geq$ 45 years) women. No statistical sampling was attempted in the field, because of obvious reasons e.g. suspicion. Thus, total enumeration of 5 settlements for affected group and 4 settlements for control group have been done. However, individuals who have been persuaded to participate and voluntarily agreed to participate with written consent were only included in the present study. In the present study, data were collected after getting prior approval from the Ethical Committee for the Protection of Research Risks to Humans, Indian Statistical Institute. As a note of caution the data may have some unavoidable limitations like estimation of exact age of the respondents due to absence of written records, records of all pregnancies and prenatal deaths due to recall lapse. The chances of under-reporting of miscarriage/ abortion due to recall lapse or cultural taboos cannot be ruled out and that has been reported in several other studies (Johnston & Kensinger, 1971; Jorde, 1986).

Data analysis:

Calculation of selection intensity index

Both Crow's (1958) as well as Johnston and Kensinger's (1971) indices were applied to find out the selection intensity. The later investigators have additionally taken into account the prenatal deaths. The following formulae were used to calculate the index of selection intensities.

Crow's index $I = I_m + I_f / P_s$ where $I_m = (P_d/P_s)$, $P_s = (1 - \overline{P_d})$ and $I_f = V_f / X^2$

Where I = index of total selection intensity, I_m= index of selection due to mortality, P_d= probability of deaths up to prereproductive age (i.e. before 15 years), P_s= probability of survival up to reproductive age, I_f= index of selection due to fertility, V_f = variance due to fertility and $\overline{X}$= mean number of live births.

Johnston and Kensinger's index

$I= I_{me}+ I_{mc}/P_b + I_f/ P_b \times P_s$ where $I_{me}= (P_{ed}/ P_b)$, $P_b= (1 – P_{ed})$, $I_{mc}= (P_d/ P_s)$, $P_s = (1 – P_d)$ and

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

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 (i.e. before 15 years), P_s = probability to survive till reproductive age, I_f = index of total selection due to fertility, V_f = variance due to fertility and $\overline{X}$ = mean number of live births per women.

Descriptive statistical analyses have been done for all parameters. All the analyses have been done using IBM SPSS 16.0 version computer package.

RESULTS:

Table 1 shows demographic characteristics of the both groups. There were 82 mothers in affected group and 56 mothers in control group who had completed their fertile period (i.e. age range 45 years and above). In affected group, a total number of 380 pregnancies were recorded out of which 358 were live births and in control group, 224 pregnancies were recorded out of which 221 were live births. The mean live birth was slightly high in affected group (4.37± 1.97) as compared to control group (3.95 ± 2.24).

Table 1 also presents mortality data (prenatal, infant, child and pre-reproductive). A total number of 22 prenatal deaths including abortions and still births were reported by the women of affected group, while the women of control group reported only 3 prenatal deaths. So, the prenatal death rate in affected group was quite high (5.79%) compared to control group (1.34%). Data on post-natal mortality including infant (death before 1 year), child (death before 5 years) and pre-reproductive (death before 15 years) shows a similar trend in both groups. Infant mortality was 6.42% in affected group and 8.14% in control group. Child and

pre-reproductive mortality was 10.61% and 13.69% in affected group and 12.67% and 16.74% in control group.

Table 1: Demographic characters of the two populations

Variables	*Affected group*	*Control group*
Total No. of Women	82	56
Total No. Pregnancy	380	224
Total No. of Live birth	358	221
Mean Live birth	4.37 ± 1.97	3.95 ± 2.24
Variance Live birth	3.90	5.00
Prenatal deaths	22 (5.79)	3 (1.34)
Infant mortality (death before 1 yr)	23 (6.42)	18 (8.14)
Child mortality (death before 5 yrs)	38 (10.61)	28 (12.67)
Pre-reproductive mortality (death before 15yrs)	49 (13.69)	37 (16.74)

Figures in the parenthesis indicate death per 100 individuals

Table 2 shows value of selection intensity index and its parameters. Relatively high fertility index (I_f) was observed in control group (0.322) compared to affected group (0.204). On the other, prenatal mortality index (I_{me}) was relatively high in affected group (0.062) compared to control group (0.013). In case of post natal mortality index (I_m), both the study groups shows higher values (affected group= 0.159 and control group= 0.200).

The computed value of selection intensity as per Crow's method was 0.395 for affected group, 0.587 for control group. While using Johnston and Kensinger's method, the selection intensity value was 0.482 for affected group, 0.606 for control group. The increase of selection intensity value in Johnston and Kensinger's method may be due to additional contribution of prenatal mortality (Figure 1).

Table 2: Selection intensity and its parameters

	Crow's (1958)				*Johnston and Kensinger's (1971)*			
	I_f	**I_m**	**I_f/P_s**	**I**	**I_{me}**	**I_{mc}/P_b**	**$I_f/P_b.P_s$**	**I**
Affected group	0.204	0.159	0.236	0.395	0.062	0.169	0.251	0.482
Control group	0.322	0.200	0.387	0.587	0.013	0.201	0.392	0.606

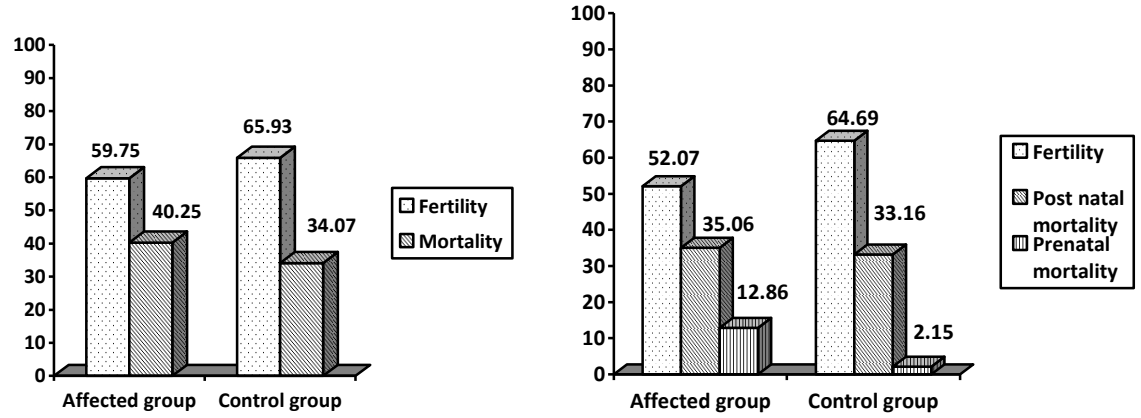

Fig 1: Contribution of fertility and different mortality components (in %) to selection intensity index [Using Crow method (Left), Using Johnston & Kensinger's method (Right)]

DISCUSSION:

Objective of the present study was to investigate the intensity of selection of two Santal groups exposed to different environmental condition of Birbhum district, West Bengal. The consideration was both the groups have had same genetic endowment (practice endogamy), socio-economic conditions and more or less similar geo-climatic condition. However, affected group was severely exposed to adverse environmental exposure, the idea was to examine the selection intensity (or fitness) of that group compared to other group in the district.

Result indicates exposure to stone dusts, noise and other environmental hazards has markedly influenced the selection intensity and selected demographic events of affected group. Comparing present study groups with other tribal populations of West Bengal like Pahira (Basu, 1967), Serpa (Gupta, 1980), Lepcha (Mukhopadhyay, 1982), Toto (Debnath & Sen, 1983), Oraon (Das, 1997), Munda, Lodha and Santal (Kapoor & Kshatriya, 2000) present study consistently show low values of selection intensity in affected group but control group show more or less similar values with other published data irrespective of the calculation methods (Crow, 1958; Johnston and Kensinger, 1971). It indicates that individuals of affected group were less selected to their respective environment i.e. dust and noise polluted environment than individuals of control group, which is relatively free from all those hazards.

Furthermore, selection mechanism is affected by differential mortality (both prenatal and post natal) in affected group which corroborates with other findings where populations living in

adverse environmental condition (Basu *et al.*, 1988; Reddy and Chopra, 1990; Kapoor & Patra, 1998; Goutam *et al.*, 2009). On the contrary, fertility plays a great role in control group where environmental stress is very little (Kapoor & Kshatriya, 2000; Das & Sikdar, 2010; Sikdar, 2012).

The study shows a higher fertility rate among both the study populations indicative of poor family planning practice because of poor literacy level and inadequate knowledge although there is no supportive data to prove this statement. Data shows that women of affected group, experienced more number of pregnancies and live births than the women of control group. However, fertility index is lower in affected group than control group because of low individual variation in fertility among affected group than control group.

Several studies have suggested that infant and child mortality is a useful indicator of community health. Because, children are most susceptible towards harmful effects of environment including infections, malnutrition, poor maternal and health care facilities (Watson *et al.*, 1995; Kapoor *et al.*, 2003; Das & Sikdar, 2010; Sikdar, 2012). In the present study, occurrence of infant, child and pre-reproductive death is relatively much higher (in both groups) compared to the other Santal populations of West Bengal (Kapoor & Kshatriya, 2000). In most of the cases, unspecified fever, diarrhoea, respiratory infections were common reasons for such child deaths that needs further investigation.

Present study also attempted to estimate reproductive wastages in both groups. Prenatal mortality is much higher in affected group who (pregnant women) were exposed to environmental hazards and were engaged in heavy manual labour in an adverse environment. WHO (1995; 2004) reported exposure to heavy manual labour for long hours and other work place or environmental hazards in the mining area increase the risk of still birth, abortion and other adverse reproductive outcomes of the women. The prenatal mortality index is also quite high in affected group compared to the Oraons (Das, 1997), Santal and Munda (Kapoor & Kshatriya, 2000), but less than Lodhas of West Bengal (Kapoor & Kshatriya, 2000).

However, it is not possible to generalize that exposure to environmental hazards have adverse health effect on human population with only such demographic events, more studies at different environmental settings with a number of sensitive test protocols are required to generalize such statements.

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