

Fertility and Mortality Differentials Among The Different Population Groups of Sikkim, India

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ABSTRACT Selection potential based on differential fertility and mortality has been computed for various sub-groups of Buddhists and Hindus of Sikkim using the methodology of Crow (1958) and Johnston and Kensinger (1971). It is evident that irrespective of methodology the index of total selection among Buddhists was found to be highest among Bhutias (0.477) and the lowest among Tamangs (0.394). Among the Hindus, however, the highest value for the index of total selection as computed by Crow's methodology was obtained for Limboos (0.472) while its value was found to be highest for Scheduled Caste group (0.515) when computed through Johnston and Kensinger's methodology. These differences can be accounted for by the fact that Johnston and Kensinger's takes into account embryonic mortality, which is fairly high among Scheduled Castes group.

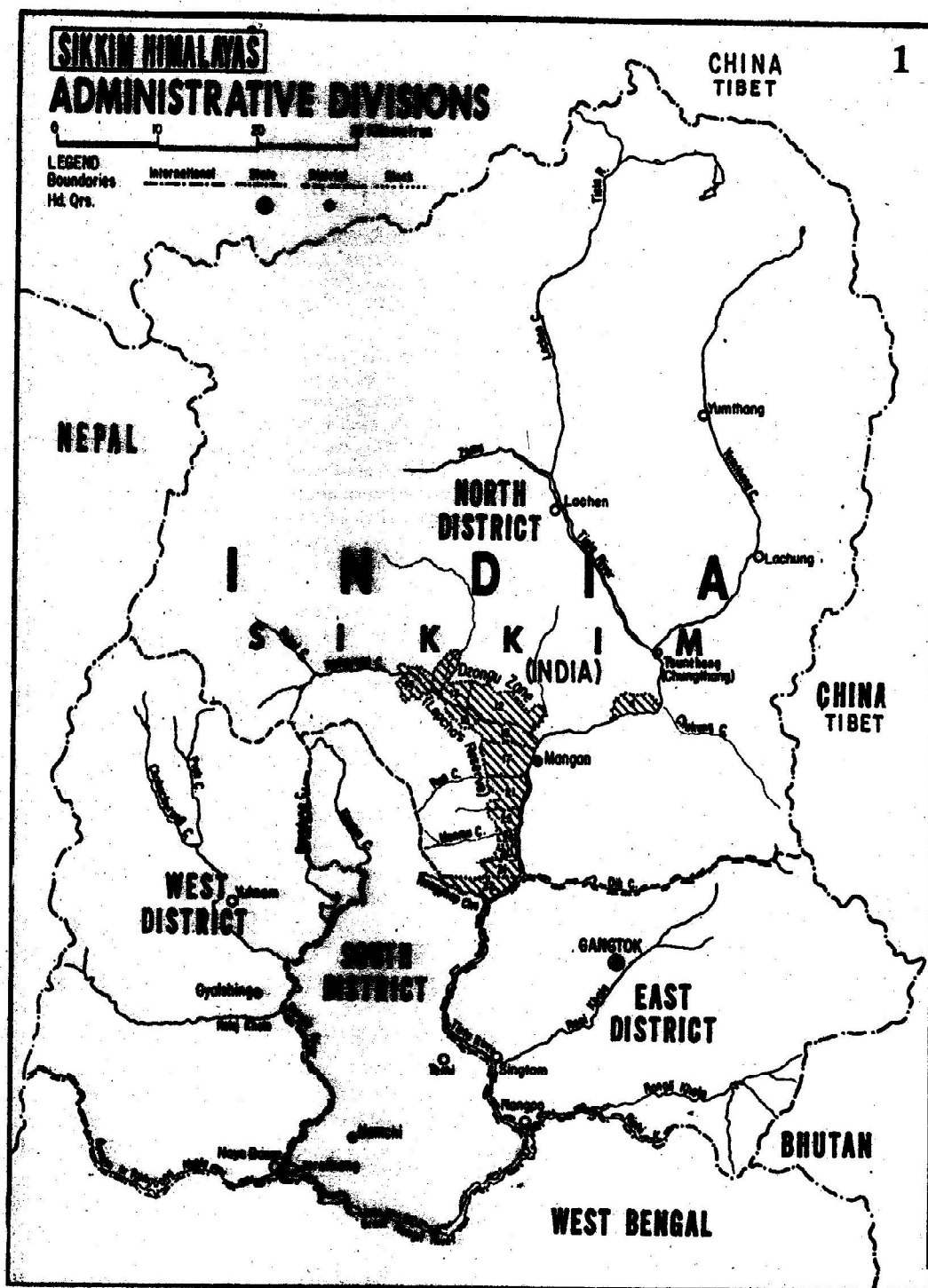
The relative contribution of fertility component to the index of total selection in the present investigation has been found to be higher than corresponding mortality component among Buddhists as well as among Hindus. Interestingly though, among most of the sub-groups of Buddhists and Hindus it is the contribution of mortality component to the Index of total selection which exceeds the fertility component.

Reports are available which have brought forth evidence in support of the contention that the socio-economic and socio-cultural milieus of a population have tremendous impact in the fertility and mortality components and subsequently on selection (Spuhler, 1963, 1976; Johnston and Kensinger, 1971; Tripp-Reimer, 1980; Jorde and Durbize, 1986). In India, a few studies have demonstrated the validity of the role of natural selection in imposing characteristic fertility and mortality differentials among the different population groups (Ghosh, 1970; Barua, 1976; Murty and Ramesh, 1978; Chengal Reddy and Lakshmanudu, 1979; Rao and Murty, 1984; Basu et al., 1988).

Sikkim is a border state and its strategic importance is well known. Hemmed in on the west by Nepal, on the north by Tibet and to the east by Tibet and Bhutan, the position of Sikkim is without parallel in the Himalayas. Surrounded thus,

Sikkim enjoyed and still retains unusual distinctiveness. Though strongly influenced by Tibet in religion and customs, politically and economically the major factors of change have resulted from its close ties with India. It was a protectorate of India until 26th April 1975, when it became the twenty second state of the Union of India.

Sikkim is a hill state and lies in the Eastern Himalayas between 27° and 28°N latitude and 88° and 89° E longitude (Fig. 1). To its north lie vast stretches of the Tibetan plateau, to the west the Kingdom of Nepal, to the east the Kingdom of Bhutan and the Chumbi valley of Tibet, and to the south the Darjeeling district of West Bengal. With an area of 7299 sq. km. Sikkim is almost rectangular: 113 km long and 64 km wide. It is a wholly mountainous state, and the elevation of hill ranges varies from 300 to 8400 m above mean sea level. The proximity to Kanchenjunga, the direction of its valleys and the fact that



it lies in the direct path of the monsoon make Sikkim by far the wettest place of the whole area. The climate varies from sub-tropical to alpine depending upon the altitude. Sikkim has an annual rainfall of about 1250 mm even in the dry upper valleys of Lachung and Lachen, increasing to about 3500 mm in other districts. The relative humidity remains above 70% throughout the year at most of the places of Sikkim. The temperature varies with altitude and slope aspect (generally 6° to 10°C per km). The maximum temperature is + 19.9°C, the minimum temperature is +11.4°C (at Gangtok station). Its climatic conditions with very high humidity accompanied by warm temperature favour proliferation of diseases and pests both in endemic and epidemic forms.

According to the 1981 census the population of Sikkim is 3,16,385 out of which 2,65,301 are rural and 51,084 urban i.e. 84 per cent of the total population is rural (Census of India 1981, Series 19 Part IIA and Part IIB). The population density is low (on an average 44 per sq. km.) and varies from one region to the other. Most of the people live in the West, South and East districts of Sikkim, whereas the North district is largely uninhabited because of its altitude, which is on an average more than 6000 m above sea level. The West, South and East districts of Sikkim are inhabited by various ethnic groups, the distribution of them is chaotic. There are practically no closed areas of settlements, and various groups are scattered irregularly over the state and dovetailed into each other in an extraordinary way except North district, where Lepchas in the Dzongu zone and Bhutias in Lachen and Lachung are compartmentalized (Fig. 1).

Many languages and dialects are spoken in Sikkim, but almost ninety per cent of the people understand Nepali, the lingua-franca of the state. Other dialects of ancient Nepali Tribes which are in use are Gurung, Limbu, Kharabu, Mangeri and Murmi. Lepchas and Bhutias speak their own language, though many of them can understand Nepali as all their agricultural labourers and helpers are Nepalese.

Buddhism, Hinduism and Animism are prac-

ticed by different ethnic groups, but it is difficult to classify them accurately. Some Nepalese are Hindus and others are Buddhists while Lepchas are animists and Buddhists. Religion of Scheduled Castes is uncertain.

Sikkim is the only state in India, which exhibits such ethnic, linguistic and cultural diversity within such a small area.

The ethnohistoric characteristics of the various groups represented in Sikkim are as follows:

Lepchas: They are about 13 per cent of the total population and are one of the Scheduled Tribes. They are probably of indigenous origin since they have no recorded history of migration. Buddhism was accepted as a religion by most of the Lepchas. Whereas the Lepchas formerly subsisted upon hunting and shifting cultivation- the dense forests, in which they constructed pile dwellings made of bamboo (Si-kkim, Tibetan = bambo houses), they are now mainly landowners or workers on the land. In the Dzongu area of North Sikkim their chief occupation is cardamum cultivation with very limited activities for horticulture and agriculture pertaining to other crops. It may be mentioned here that this area has remained inaccessible for a long time and no one other than a person originally from this area was permitted to trade or reside there. Thus one can say that the Lepchas of the Dzongu area (North Sikkim Lepchas) are culturally the most isolated group. The language of the Lepchas belongs to the Himalayan group of the Tibeto-Chinese language family.

Bhutias: The Bhutias are of Tibetan origin (Bhutia means Tibetan). They are about 14 per cent of the total population and are also a Scheduled Tribe. Most of them are now-a-days farmers, but some of them are still herdsmen and breeders of sheep and yaks, which is their original profession. Their religion is Buddhism, and their language belongs to the Bhotia group of the Tibeto-Chinese language family. The Bhutias, who took refuge in Sikkim after the Schism in Tibet in 15th and 16th century, are now spread out in all the districts of Sikkim. The Bhutias

living in North Sikkim are also known as Lachenpas and Lachungpas. The Lachenpas of Lachen (see Fig. 1) form a compact group, having migratory habits of moving up to colder places with their yaks and sheep during summer for almost six months and returning to their homes during the colder months. The Lachungpas of Lachung (see Fig. 1) are also migratory and their habits are more or less similar.

Sherpas: The Sherpas, another Scheduled Tribe of Sikkim, constitutes about 3.7 per cent of the total population. They are mainly found in the western parts of Sikkim. The Sherpas originated most likely from East Tibet, and migrated from there to the eastern parts of Nepal, which they reached in the first decades of 16th century. During the last three centuries some groups of them immigrated into the adjacent parts of Sikkim. There is some evidence that the Sherpas have mixed with the Tibetans (Bhutias). Most of them are small land-owners or cultivators. They are followers of Buddhism. Their language belongs to the Bhotia group of the Tibeto-Chinese family.

Tamangs: The Tamangs form about 5 per cent of the total population of Sikkim. They are also followers of Buddhism and are said to have come originally from Central Tibet. Their language is classed with the Tibeto-Chinese language family (Himalayan group). Tamangs are mostly farmers. They are spread over all parts of West, South and East Sikkim, which they populated long ago from Nepal. They are therefore one of the so-called ancient Nepalese Group.

Brahmans and Chhetris: They constitute about 8.5 per cent and 11.5 per cent of the population of Sikkim respectively. They are spread in all the districts of Sikkim except the North. Their language is Nepali (Indo-European language family). The name Chhetri is probably derived from Kshatriya (warrior caste of the Hindu caste system). These two Indo-Nepalese groups are of Caucasoid origin and immigrated into Sikkim mostly during the last hundred years.

Pradhans (Newars): The Pradhans belong to the Newars are members of the Ancient Nepalese Group. They are Hindus by religion. Their language belongs to the Tibeto-Chinese language family (Himalayan group). They constitute about 3.5 per cent of the Sikkim population. The Newars were the first people of Kathmandu valley, from where they immigrated into Sikkim. In Nepal they are divided into two great religious groups: Hindus and Buddhists. The Pradhans of Sikkim belong to the Hindustic Shrestha caste group. Their main occupations are trade and handicrafts.

Rais: The Rais form now 14.6 per cent of the total population of Sikkim and are concentrated in the Western and Southern districts of Sikkim. They are Hindus and belong linguistically to the Tibeto-Chinese language family (Himalayan group). Together with the Limboos they are known as Kiranti group, which most likely has its origin in Tibet. Thus Rais and Limboos have apparently a common origin, but today they live separately.

Limboos/Subbas: This group is also addressed as Subbas, which means headman or chief. They constitute 9.4 per cent of the population of Sikkim and are mostly found in the western and southern parts of the country. In other respects, too, they correspond to the Rais, with whom they form another Ancient Nepalese Group, which immigrated into Sikkim during the last two centuries.

Gurungs: The Gurungs (about 6 per cent of the total population of Sikkim) belong also to the Ancient Nepalese Group, but they are Hindus. Their language belongs to the Himalayan group of the Tibeto-Chinese language family. Gurungs are most likely to be traced back to one of the old Mongoloid mountain population of Nepal, which have mixed with caucasoid immigrants coming from South, and which have given up their traditional cultural patterns including religion and language. They immigrated into Sikkim during the last two centuries.

Mangars: In this connection another Sikkim population has still to be mentioned, the Mangars, who are related to Newars and are only 2.6 per cent of the total population of Sikkim. They are Hindus by religion. Their language belongs to the Himalayan group of the Tibeto-Chinese family. The Mangars are the largest ancient ethnic group of Nepal, from where parts of them immigrated into Sikkim, where they are mostly spread in the West and South districts.

Scheduled Castes: The five castes—Damai (Tailors), Kami (Smiths), Lohar (Black smiths), Maji (Fishermen) and Sarki (Cobblers) are referred as Scheduled Castes of Sikkim. They are about 6 per cent of the total population of Sikkim and immigrated during the last hundred years from Nepal and West Bengal. Their language belongs to the Indo-European language family, their religion is Hinduism.

Thus, one finds a tremendous ethnic, linguistic and cultural diversity within such a small area of Sikkim. Against this backdrop, it seems reasonable that differential fertility and mortality along with their ethnic and cultural diversity may have significant impact on natural selection potential.

MATERIAL AND METHODS

The study sample was collected from four Districts of Sikkim State and comprised of 281 Buddhist and Hindu mothers who have completed their reproductive performance. The households were selected after an extensive field visit to the various districts of Sikkim identifying the villages predominantly inhabited by these two communities viz., Buddhists and Hindus. From North District of Sikkim, Lepchas and Bhutias have been analysed separately. A nuclear family ultimately was taken as the unit of the study.

The fertility and mortality data were collected using structured scheduled and through genealogies. Reproductive performance data were collected by obtaining information on the serial outcome of each pregnancy. The collected information was also cross-checked from elderly members of the household.

The index of total selection has been computed following Crow (1958) and Johnston and Kensing (1971). The two indices are

$$I_1 = I_m + \frac{1}{P_s} \times I_f \quad (\text{Crow, 1958})$$

and

$$I_2 = I_{ms} + \frac{1}{P_b} I_{mc} + \frac{1}{P_b P_s} I_f \quad (\text{Johnston \& Kensing, 1971})$$

where $I_m = \frac{P_d}{P_s}$; and

$I_f = V_x / (\bar{x})^2$ where V_x , & $\bar{x}$ is variance of life births and average no. of life births respectively

$$I_{ms} = \frac{1 - P_b}{P_b} \quad \text{and} \quad I_{mc} = \frac{1 - P_s}{P_s}$$

P_b , P_s , P_d , are explained in Table 1 footnotes.

RESULTS AND DISCUSSION

Results of the analysis on fertility and mortality data in 137 Buddhist and 144 Hindu women who have completed their reproductive life span are presented in Tables 1 and 2 respectively. Among the Buddhists, Tamangs shared highest number of average live births (6.71 ± 0.60) while the Sherpas and Bhutias showed 5.64 ± 0.75 and 5.41 ± 0.29 number of average live births, respectively. The overall average number of livebirths among Buddhists has been found to be 5.77 ± 0.23 . The proportion of survivors from birth to reproductive age (P_s) was highest for Bhutias (0.842) and lowest for Lepchas (0.809). The proportion of survivors among Sherpas and Tamangs was found to be 0.839 and 0.824 respectively. The Buddhists in general, showed a value of 0.800 for the proportion of survivors from birth to reproductive age.

Similarly among Hindus, the Brahmins showed the highest number of average live birth

Table 1: Demographic variables used in calculating index at selection potential

Population group	No. of mothers	No. of reported pregnancies	No. of live births	Average no. of live births $\bar{x}$	Variance of live births $V\bar{x}$	P_s	P_d	P_b	$P_b P_s$
I. Buddhists									
1. Lepchas									
Lepchas, North Sikkim	24	168	157	6.54±0.47	5.25	0.764	0.236	0.934	0.713
Lepchas, Rest Sikkim	16	88	84	5.25±0.45	3.31	0.893	0.107	0.954	0.852
Lepchas Total	40	256	241	6.02±0.33	4.47	0.809	0.191	0.941	0.761
2. Bhutias									
Bhutias, North Sikkim	35	195	186	5.31±0.40	5.53	0.871	0.129	0.954	0.831
Bhutias, Rest Sikkim	34	190	187	5.50±0.44	6.48	0.813	0.187	0.984	0.800
Bhutias Total	69	385	373	5.41±0.29	6.01	0.842	0.158	0.969	0.816
3. Sherpas	11	62	62	5.64±0.75	6.23	0.839	0.161	1.000	0.839
4. Tamangs	17	115	114	6.71±0.60	6.20	0.824	0.176	0.991	0.816
Buddhists (Total)	137	818	790	5.77±0.23	7.51	0.800	0.200	0.966	0.773

Where P_s = Proportion of survivors from birth to reproductive age $P_d = (1 - P_s)$ = Proportion of pre-reproductive deaths P_b = Proportion of survivors to birth $P_b P_s$ = Proportion of survivors from early embryo to reproductive age.

Table 2: Demographic variables used in calculating index of total selection

Population group	No. of mothers	No. of reported pregnancies	No. of live births	Average no. of live births $\bar{x}$	Variance of live births $V\bar{x}$	P_s	P_d	P_b	$P_b P_s$
II. Hindus									
1. Brahmans	15	113	109	7.27±0.72	7.79	0.826	0.174	0.965	0.797
2. Chhetris	23	156	150	6.52±0.47	5.12	0.867	0.133	0.961	0.833
3. Pradhans (Newars)	22	164	159	7.23±0.52	6.08	0.824	0.176	0.969	0.798
4. Rais	20	120	119	5.95±0.42	3.54	0.882	0.118	0.992	0.875
5. Limboos/Subbas	12	63	63	5.25±0.34	8.52	0.889	0.111	1.000	0.889
6. Gurungs	19	131	131	6.89±0.65	7.99	0.824	0.176	1.000	0.824
7. Mangars	13	81	79	6.08±0.52	3.46	0.861	0.139	0.975	0.839
8. Scheduled Castes	20	128	117	5.85±0.61	7.51	0.880	0.120	0.914	0.804
Hindus (Total)	144	956	927	6.44±0.69	8.25	0.853	0.147	0.970	0.827

(7.27 ± 0.72) while the Limboos showed the lowest number of average live births (5.25 ± 0.84). The over all average number of live births for Hindu women was found to be 6.44 ± 0.69 . The proportion of survivors from birth to reproductive age (P_r) was found to be highest among Limboos 0.889 and lowest among Pradhans and Gurungs each revealing 0.824. The overall proportion of survivors from birth to reproductive age for Hindus was found to be 0.853. It is worthwhile to state that Hindu women represent higher values for average live births together with a higher proportion of survivors from birth to reproductive age as compared to Buddhists.

The indices of total selection among Buddhists have been computed and presented in Tables 3 and 4 respectively. It is evident that irrespective of methodology (Crow, 1958; Johnston and Kensinger, 1971), the total index of selection was found to be highest among Bhutias (0.477) and lowest among Tamangs (0.394). The index of total selection for Buddhists—all the sub-groups taken together—comes out to be 0.586.

Further, it may be pointed out that relative contribution of fertility component to the index of total selection exceeds mortality component among Bhutias and Sherpas, while in the other two groups namely Lepchas and Tamangs, the mortality component is higher than the corresponding fertility component. However, the percentage of fertility component exceeds mortality component when all the sub-groups are treated together as one group *i.e.* All Buddhists.

Similarly, the indices of total selection among Hindus have been computed and presented in Tables 5 and 6 respectively. Interestingly, the index of total selection as computed by Crow's methodology yields the highest value for Limboos (0.472) while its value is found to be highest for Scheduled Castes group (0.515) when computed through Johnston and Kensinger's methodology. These differences may be accounted for by the fact that latter methodology takes into account the embryonic mortality in computing index of total selection and which is fairly high in Scheduled Castes group. Nev-

ertheless, Rais showed the lowest value of the index of total selection when computed through either of the two methodologies. The index of selection potential for all Hindus comes out to be 0.449, a figure smaller than All Buddhists (0.586). Again, this can be explained on the basis of the fact that Buddhists reveal comparatively less number of average live births along with a higher proportion of pre-reproductive deaths.

Among the Hindus, the relative contribution of fertility component to the index of total selection exceeds the mortality component among the Limboos and Scheduled Castes only, while in all other sub-groups, the mortality component is higher than the fertility component. However, the percentage contribution of fertility component is more than that of mortality component when all the sub-groups are pooled together.

As far as the proportion of embryonic mortality is concerned, it was computed through Johnston and Kensinger's methodology. The results for Buddhists and Hindus are presented in Tables 4 and 6 respectively. It is evident that among Buddhists the contribution of pre-natal mortality varies from a maximum of 13.24 per cent in Lepchas to (0.00) in Sherpas. However, the overall contribution of pre-natal mortality among the Buddhists was 5.97 per cent.

Similarly among Hindus, the contribution of embryonic mortality to the index of total selection varies from (0) in Limboos and Gurungs to 8.25 per cent in Scheduled Castes group. Among all Hindus, the contribution of pre-natal mortality was found to be 6.90 per cent. Although Hindus showed slightly higher percentage of pre-natal mortality, it is desired to have data on a larger series of these two different communities to have a better insight of the magnitude of the problem of embryonic loss as these values may be underestimated due to inability of the informants to accurately recollect all the episodes of embryonic losses and also due to their hesitation in providing such information because of their inherent sociocultural beliefs and taboos.

In the context of post-natal mortality, the mortality figures among the population groups under

Table 3: Index of selection potential based on live births and subsequent pre-reproductive mortality (Crow, 1958)

Population group	I_l	I_m	I_f	I_f/P_s	Percentage of fertility component	Percentage of post-natal mortality component
I. Buddhists						
1. Lepchas						
Lepchas, North Sikkim	0.470	0.309	0.123	0.161	34.26	65.74
Lepchas, Rest Sikkim	0.254	0.120	0.120	0.134	52.76	47.24
Lepchas Total	0.388	0.236	0.123	0.152	39.17	60.82
2. Bhutias						
Bhutias, North Sikkim	0.373	0.148	0.196	0.225	60.32	39.68
Bhutias, Rest Sikkim	0.493	0.230	0.214	0.263	53.35	46.65
Bhutias Total	0.431	0.188	0.205	0.243	56.38	43.62
3. Sherpas	0.426	0.192	0.196	0.234	54.93	45.07
4. Tamangs	0.381	0.214	0.138	0.167	43.83	56.17
Buddhists (Total)	0.532	0.250	0.226	0.282	53.01	46.99

$$I_l = I_m + \frac{1}{P_s} \times I_f$$

$$\text{where } I_m = \frac{P_d}{P_s} \text{ and } I_f = \frac{V\bar{x}}{(\bar{x})^2}$$

Table 4: Index of total selection potential based on total pregnancies and total pre-reproductive mortality including embryonic mortality (Johnston and Kensinger, 1971)

Population group	I_2	I_{me}	I_{mc}	I_f	I_f/P_bP_s	I_{mc}/P_b	Percentage of fertility component	Percentage of post-natal mortality component	Percentage of embryonic mortality component
I. Buddhist									
1. Lepchas									
Lepchas North Sikkim	0.574	0.071	0.309	0.123	0.172	0.331	29.97	57.66	12.37
Lepchas, Rest Sikkim	0.314	0.048	0.120	0.120	0.141	0.125	44.90	39.81	15.29
Lepchas Total	0.476	0.063	0.236	0.123	0.162	0.251	34.03	52.73	13.24
2. Bhutias									
Bhutias, North Sikkim	0.439	0.048	0.148	0.196	0.236	0.155	53.76	35.31	10.93
Bhutias, Rest Sikkim	0.517	0.016	0.230	0.214	0.267	0.234	51.64	45.26	3.09
Bhutias Total	0.477	0.032	0.188	0.205	0.251	0.194	52.62	40.67	6.70
3. Sherpas	0.426	—	0.192	0.196	0.234	0.192	54.93	45.07	—
4. Tamangs	0.394	0.009	0.214	0.138	0.169	0.216	42.89	54.82	2.28
Buddhists (Total)	0.586	0.035	0.250	0.226	0.292	0.259	49.83	44.20	5.97

$$I_2 = I_{me} + \frac{I}{P_b} I_{mc} + \frac{I}{P_b P_s} \times I_f$$

$$\text{where } I_{me} = \frac{I - P_b}{P_b} \text{ and } I_{mc} = \frac{I - P_s}{P_s}$$

Table 5: Index of selection potential based on live births and subsequent pre-reproductive mortality (Crow, 1958)

Population group	I_1	I_m	I_f	I_f / P_s	Percentage of fertility component	Percentage of postnatal mortality component
II. Hindus						
1. Brahmans	0.388	0.210	0.147	0.178	45.88	54.12
2. Chhetris	0.391	0.153	0.120	0.138	47.42	52.58
3. Pradhans (Newars)	0.354	0.213	0.116	0.141	39.83	60.17
4. Rais	0.247	0.134	0.100	0.113	45.75	54.25
5. Limboos/Subbas	0.472	0.125	0.309	0.347	73.52	26.48
6. Gurungs	0.417	0.213	0.168	0.204	48.92	51.08
7. Mangars	0.270	0.161	0.094	0.109	40.37	59.63
8. Scheduled Castes	0.385	0.136	0.219	0.249	64.68	35.32
Hindus (Total)	0.405	0.172	0.199	0.233	57.53	42.47

Table 6: Index of selection potential based on total frequencies and total pre-reproductive mortality including embryonic mortality (Johnston and Kensinger, 1971)

Population group	I_2	I_{me}	I_{mc}	I_f	$I_f / P_b P_s$	I_{me} / P_b	Percentage of fertility component	Percentage of post-natal mortality component	Percentage of embryonic mortality component
II. Hindus									
1. Brahmans	0.438	0.036	0.210	0.147	0.184	0.218	42.01	49.77	8.22
2. Chhetris	0.343	0.040	0.153	0.120	0.144	0.159	41.98	46.36	11.66
3. Pradhans (Newars)	0.397	0.032	0.213	0.116	0.145	0.220	36.52	55.42	8.06
4. Rais	0.257	0.008	0.134	0.100	0.114	0.135	44.36	52.53	3.11
5. Limboos/Subbas	0.472	—	0.125	0.309	0.347	0.125	73.52	26.48	—
6. Gurungs	0.417	—	0.213	0.168	0.204	0.213	48.92	51.08	—
7. Mangars	0.303	0.026	0.161	0.094	0.112	0.165	36.96	54.46	8.58
8. Scheduled Castes	0.515	0.094	0.136	0.219	0.272	0.149	52.82	28.93	18.25
Hindus (Total)	0.449	0.031	0.172	0.199	0.241	0.177	53.68	39.42	6.90

study *i.e.* Buddhists and Hindus seem to be high in terms of absolute numbers. However the proportion of post-natal deaths to reproductive age is much less when compared with other tribal and rural population groups of the country (Murty and Ramesh, 1978; Rao and Murty, 1984) and consequently these authors reported high selection index due to higher mean live birth and higher mortality.

In the present analysis, comparatively low values of mortality component without appreciable decline in average live births has resulted in low values of Index of selection potential.

Studies among Indian tribes indicate that pre-reproductive mortality contributes heavily to the process of natural selection, whereas in the population of industrially developed countries pre-reproductive mortality is extremely low (Spuh-

ler, 1962; Cavalli-Sforza and Bodmer, 1971). While the extent of pre-reproductive mortality associated with nongenetic causes is not known, it can be presumed that endemic diseases such as malaria, smallpox, cholera and gastrointestinal parasites which are characteristic of the forest habitat are responsible for the higher incidence of pre-reproductive mortality. The differences in the relative contribution of the fertility component to the total index of selection may also indicate the influence of culture, behaviour, heritability of fertility, and other environmental factors on the fitness of the population. These studies also suggest that in the long run, when pre-reproductive mortality is brought to minimum, the fertility differential might become one of the main factors in the operation of natural selection even among tribal populations.

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