Hum. Hered. 32: 264–269 (1982)

Biological Effects of High Natural Background Radiation with Special Reference to Palmar Creases

M. K. Bhasin, M. S. Grewal[1], *K. J. Sudarshan, Indera P. Singh*

Department of Anthropology, University of Delhi, India

Key Words. Natural radiation · Dermatoglyphics · Palmar creases · Kerala

Abstract. The present study was conducted among the two population groups, namely Hindus and Christians, who are living in areas of high natural radiation in the southwest of Kerala. The effect of high natural background radiation on palmar crease variation was studied. Statistically significant differences were observed between the exposed group and a control group with regard to radial base crease variation and simian crease frequency.

Theoretically, any level of radiation is mutagenic and as such a higher rate of mutations is to be expected in areas of high natural background radiation.

Earlier studies of this problem were done on uranium miners in the FRG and Czechoslovakia; it was concluded that 50% of the miners died from carcinoma of the lung [15]. Other studies followed, and two of the most extensively studied areas are the Esperite Santo state in Brazil and the southwest coast of the Kerala state in India.

In a most comprehensive study in the Brazilian area *Freire-Maia and Krieger* [9] tried to ascertain whether the load acting on the offspring of consanguineous marriages is primarily segregational or mutational. Analysis of the genetic load in a multiple regression model disclosed a strong genetic component in congenital anomalies and a strong environmental component in infant mortality. In another report, *Freire-Maia* [8] discussed problems inherent in retrospective studies of human populations living under high levels of natural radiation. Recently, in a genetic and epidemiological retrospective study in Brazil, with a consideration of concomitant variables, *Freire-Maia and Krieger* [9] observed no significant effects of natural radiation on the sex ratio at birth, occurrence of congenital anomalies, number of pregnancy terminations, child mortality or fertility of couples.

Kochupillai et al. [14], assessing the biological effects of radiation in the Kerala coastal region, reported a high rate of pregnancy terminations, a high incidence of severe mental retardation and chromosomal

[1] All India Institute of Medical Sciences, New Delhi, India.

Table I. Radial base crease variation among Hindus

	Males				Females			
	right		left		right		left	
	E	C	E	C	E	C	E	C
SRBC S_1	0	3	1	4	0	3	1	3
S_2	1	0	0	1	0	0	0	0
S_3	2	4	1	2	3	5	1	4
S_4	2	0	3	0	3	2	3	4
S_5	1	0	0	0	0	2	0	0
Total	6	7	5	7	6	12	5	11
DRBC D_1	0	2	0	0	0	0	0	0
D_2	0	0	0	0	0	0	0	2
D_3	2	12	4	10	4	13	3	9
D_4	10	20	9	23	8	13	10	19
D_5	1	1	1	0	0	1	1	0
D_6	0	0	0	0	0	0	0	0
Total	13	35	14	33	12	27	14	30
TRBC	1	3	1	5	3	5	2	3

E = Exposed group; n: males = 20, females = 21; C = control group; n: males = 45, females = 44; SRBC = single radial base crease; DRBC = double radial base crease; TRBC = triple radial base crease.

changes, and a high frequency of Down's syndrome. Similar findings were reported by *Grewal* et al. [10]. The above-mentioned studies provide ample evidence that radiation is one of the factors that influence normal fetal development.

Palmar crease variation has been known to be associated with various congenital malformations for a long time. The origin of such malformations could be genetic [11] or environmental [1, 12]. A variety of palmar crease variations may be indicative of intrauterine disturbances early in pregnancy [6]. The role of natural radiation in causing such disturbances in the dermatoglyphic variables has been investigated by *Ahuja* et al. [2] and *Bhasin* et al. [5]. The present report aims at studying the effect of high natural background radiation on palmar creases.

Materials and Methods

The sample was taken from the Chavara-Neendakara coastal strip on the southwest coast of Kerala. The inhabitants of this area receive a radiation dose of 1,500 mR/year which is 15 times the normal average dose [16].

Palm prints from exposed Hindu and Christian subjects were collected from the Puthanthura and Karithura villages, respectively. The control prints were obtained from a radiation-free area further north, i.e. the Purakhode and Punnapara villages. The sample size and sex ratio appear from tables I

Table II. Radial base crease variation among Christians

	Males				Females			
	right		left		right		left	
	E	C	E	C	E	C	E	C
SRBC S_1	0	0	0	1	0	0	1	1
S_2	1	0	1	0	0	0	0	0
S_3	3	3	2	2	7	4	3	2
S_4	1	1	2	1	2	2	1	1
S_5	0	0	0	0	0	0	0	0
Total	5	4	5	4	9	6	5	4
DRBC D_1	0	0	0	0	0	0	0	0
D_2	0	0	0	0	0	0	0	0
D_3	0	0	0	0	1	1	3	0
D_4	7	21	7	21	12	17	15	20
D_5	0	0	0	0	0	0	0	0
D_6	0	0	0	0	0	0	0	0
Total	7	21	7	21	13	18	18	20
TRBC	2	0	2	0	2	1	1	1

E = Exposed group; n: males = 14, females = 24; C = control group; n: males = 25, females 25.

and II. Palmar creases were classified according to the schemes proposed by *Beckman* et al. [4] and *Bali and Chaube* [3].

Results

Table I shows the distribution of radial base creases among Hindus. Exposed Hindu males show a higher frequency (27.5%) of single radial base creases than the controls (15.4%). Among the females the exposed and control groups do not show much difference.

Table II shows the results obtained in the samples of Christians. The exposed males show higher frequencies of single and triple radial base crease (35.7 and 14.3%, respectively) than the control group (16.0 and 0%, respectively). This difference is statistically significant (p below 0.05). The frequency of double radial base crease is 53.5% among the exposed males and 84.0% among the controls, a difference which is also significant. The same trend is seen in females, but the difference does not reach the level of significance.

The typical simian crease is significantly more frequent in exposed Hindu males (30.0%) than in controls (8.9%). However, the exposed and control groups, males as well as females, do not differ significantly

Table III. Simian crease and transitory types in Hindus

Type	Males				Females			
	right		left		right		left	
	E	C	E	C	E	C	E	C
Typical	6	4	5	3	3	6	1	6
Transitory								
1	1	4	0	3	0	1	0	0
2	3	6	3	6	1	6	3	6
3	2	5	5	7	5	11	2	5
4	0	0	0	0	1	1	0	3
Total	6	15	8	16	7	19	5	14
Normal	8	26	7	26	11	19	15	24

Table IV. Simian crease and transitory types in Christians

Type	Males				Females			
	right		left		right		left	
	E	C	E	C	E	C	E	C
Typical	2	2	3	2	5	2	5	2
Transitory								
1	0	0	0	0	0	0	0	0
2	3	2	3	4	3	6	2	5
3	2	6	2	6	2	6	6	6
4	0	0	0	0	1	0	0	0
Total	5	8	5	10	6	12	8	11
Normal	7	15	6	13	13	11	11	12

with respect to transitory types of the simian crease.

The exposed Christian males also show a higher frequency of typical simian crease (17.8%) than the controls (8%), but this is not statistically significant.

Discussion

Flexion creases are found in embryos of about 7 weeks of gestation. Thus, their formation can be influenced by factors causing abnormal development of the embryo [17].

Particularly, the simian crease has been observed as a characteristic dermatoglyphic feature in many abnormalities, including Down's syndrome, trisomy 18, trisomy 13, Turner's syndrome and other structural chromosomal aberrations [17]. Furthermore, it has been observed in a variety of other syndromes and abnormalities with an increased frequency, e.g., in premature births, stillbirths, neonatal deaths and congenital anomalies [7]. An increased age at delivery, toxemia, hypertension and hydramnios as well as previous stillbirths in the mothers of infants with simian crease have also been reported [7]. *Johnson and Opitz* [13] observed an association between mental retardation and congenital malformations and found that relatively more mothers of children with simian crease had prenatal complications of infection and bleeding. Recently, *Dar* et al. [6] reported a high incidence of simian creases in infants being premature, small for gestational age or who had been exposed to metadone during fetal life.

By and large these reports suggest that these abnormal creases are secondary features, based on flexion of the palmar skin of the fetal hand, prone to alterations under the influence of environmental rather than primary genetic factors. As such they may provide valuable clues to the early disturbances of fetal development. Abnormal frequencies of such abnormal creases in the present context lead to the suggestion that natural background radiation may be one of the environmental factors in such prenatal disturbances.

The significant differences observed with respect to the frequencies of palmar creases cannot be wholly attributed to the influence of radiation on early fetal development. On the other hand, nonsignificant results cannot be considered as disproving an effect on the population. The question to be investigated thoroughly is whether the effects of radiation can be detected with precision and, if so, what is the contribution of other concomitant factors that operate on the population. More effective statistical models would be useful to pinpoint the biological effects, if any, caused entirely by radiation.

It may be said from the above discussion that in the present study an association between high natural background radiation and an increased frequency of simian crease has been observed.

References

1 Achs, P.; Harper, R.G.; Harrick, N.J.: Unusual dermatoglyphics associated with major congenital malformations. New Engl. J. Med. *275:* 1273 (1966).

2 Ahuja, Y.R.; Sharma, A.; Nampoothiri, K.U.K.; Ahuja, M.R.; Dempster, E.R.: Evaluation of effects of high natural background radiation on some genetic traits in the inhabitants of Monozite belt in Kerala, India. Hum. Biol. *45:* 167 (1973).

3 Bali, R.; Chaube, R.: On the formulation of palmar creases. Z. Morph. Anthrop. *63:* 158 (1971).

4 Beckman, L.; Gustavson, K.H.; Norring, A.: Finger and palmar dermal ridge patterns in normal and Mongoloid individuals. Acta genet. *12:* 20 (1962).

5 Bhasin, M.K.; Malik, S.L.; Grewal, M.R.; Singh, I.P.; Sudarshan, K.J.; Kochupillai, N.; Verma, I.C.: Effects of natural background radiation on dermatoglyphic configurations. Acta anthropogenet *4:* 1 (1980).

6 Dar, H.; Schmidt, R.; Nitowsky, H.M.: Palmar crease variants and their clinical significance. A study of newborns at risk. Pediat. Res. *11:* 103 (1977).

7 Davies, P.A.; Small Peice, V.: The single trans-

verse palmar crease in infants and children. Devl. Med. Child Neur. *5:* 491 (1963).
8 Freire-Maia, A.: Human genetic studies in an area of high natural radiation. I. Methodology. Acta Genet. med. Gemell. *18:* 175 (1969).
9 Freire-Maia, A.; Krieger, H.: Human genetic studies in areas of high natural radiation. VIII. Genetic load not related to radiation. Am. J. hum. Genet *27:* 385 (1975).
10 Grewal, M.S.; Kochupillai, N.; Verma, I.C.; Singh, I.P.; Rama-Lingaswami, V.: Genetic effects of high natural radioactivity in South India. Proc. Int. Conf. hum. Genet., Mexico (1976).
11 Holt, S.B.: The genetics of dermal ridges (Thomas, Springfield 1968).
12 Hook, E.B.; Bonefast, R.C.A.; Powers, M.L.; Greenberg, M.; Shapiro, L.R.: The human simian crease and its variants. A model for investigation of serious congenital malformations. Birth Defects *10:* 7 (1974).
13 Johnson, C.F.; Opitz, E.: The single palmar crease and its clinical significance in a child development clinic. Clin. Pediat. *10:* 392 (1971).
14 Kochupillai, N.; Verma, I.C.; Grewal, M.S.; Ramalingaswami, V.: Down's syndrome and related abnormalities in an area of high background radiation in coastal Kerala. Nature *262:* 60 (1976).
15 Lorenz, E.: Radioactivity and lung cancer. A critical review of lung cancer in the miners of Schneeberg and Joachimsthal. J. natn. Cancer Inst. *5:* 1 (1944).
16 Ponnunni Kartha, K.I.: Background radiation in the coastal Monazite areas of Kerala (S. India). Health Phys. *15:* 368 (1968).
17 Schaumann, B.; Alter, M.: Dermatoglyphics in medical disorders (Springer, New York 1976).

M.K. Bhasin,
Department of Anthropology,
University of Delhi,
Delhi-11000 (India)