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P.C. Mahalanobis' Contributions to Biometry

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Prasanta Chandra Mahalanobis was born on 29 June 1893 in Calcutta (India). He graduated with honours in Physics from Presidency College, Calcutta, in 1912. He went to England in 1913 and completed the Tripos in Mathematics and Natural Science (Physics) from King's College, Cambridge, within a short period of a year and eight months. In Part II of the Tripos, he was the only candidate to get a first class in Physics. The Cambridge University awarded him a research scholarship. Mahalanobis decided to work with C.T.R. Wilson (of Cloud Chamber fame) at the Cavendish Laboratory. Before starting his research work, Mahalanobis returned to India for a short vacation in July 1915. Just before he left England for this vacation, Mahalanobis' tutor, W.H. Macaulay, drew his attention to the journal *Biometrika*. Mahalanobis found some of the papers, in *Biometrika* very interesting, and purchased a whole set of volumes and brought them back with him to India. These volumes were later to play a decisive role in transforming Mahalanobis-the-physicist to Mahalanobis-the-statistician.

Upon request from the Principal of the Presidency College, Mahalanobis started to teach Physics during his vacation in Calcutta. Soon he found plenty of things in India to hold his interest and absorb all his working time. he decided not to return to England.

Early on, one of his mentors, Acharya Brojendranath Seal, said to him "Prasanta, .. you have to do work in India similar to that of Karl Pearson in England. In today's world, whether it is science or social service, without statistical methods there is no way. This is your job". (Translated from a note in Bengali by P.C. Mahalanobis dated 17 April 1945). Mahalanobis took up this challenge seriously, and started to carefully read Karl Pearson's papers published in *Biometrika*. He developed an interest in biometry, which was to last throughout his life and to which he was to make very profound contributions.

During the annual meeting of the Indian Science Congress Association in 1920, Mahalanobis met the Director of the Zoological and Anthropological Survey of India, N. Annandale. Annandale requested Mahalanobis to analyse some anthropometric data on a group of Anglo-Indians of Calcutta collected by him. Mahalanobis performed the analyses and published his first paper on statistics (Mahalanobis, 1922). He continued analyses of the other anthropometric measurements on this group, and presented a synthesis of the results in his Presidential Address to the Anthropology section of the Indian Science Congress in 1925. In this address titled "Analysis of race-mixture in Bengal", Mahalanobis sought to provide statistical answers to anthropological questions such as: Do the Anglo-Indians show a greater affinity with the higher castes of Bengal or with the lower castes ? Is there any appreciable admixture with the aboriginal tribes ? For answering such questions, obviously a measure of distance between population groups based on anthropometric measurements was necessary.

This note is written on the occasion of P.C. Mahalanobis' birth centenary. For an account of his many other contributions to statistics, see Rao (1974).

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Table 2: Initiation of breast-feeding in relation to parental education, per-capita income and caste (in per cent)

Particulars	*Initiation of breast feeding (hr)*			
	≤24	>25-48	>49-72	>72
Industrial				
Maternal Educatio..				
Illiterate	12	28	24	36
Upto High School	11	34	38	17
College and above	26.5	35.5	25	13
Paternal Education				
Illiterate	—	33.3	33.3	33.3
Upto High School	14	31	34.5	20.5
College and above	20	35.5	28.5	16
Per Capita Income (Rs)				
≤200	14	32	30	24
201-500	20	31	32	17
>500	16	40	28	16
Caste				
Upper	19.5	39	24	17
Lower	16	28.5	37	18.5
SC/ST	12.5	25	37.5	25
Urban				
Maternal Education				
Illiterate	28	50	16.5	5.5
Upto High School	29	48	21.5	1.5
College and above	23.5	39.5	33.5	3.5
Paternal Education				
Illiterate	60	20	20	—
Upto High School	36	41.5	19.5	3
College and above	24	40.5	32	3.5
Per Capita Income (Rs)				
≤200	12	36	48	4
201-500	26.5	38.5	32.5	2.5
>500	29.5	44	24	2.5
Caste				
Upper	23.5	44	28.5	4.5
Lower	33.5	40	26.5	—
SC/SC	26	17.5	56.5	—
Rural				
Maternal Education				
Illiterate	32	29	33.5	5.5
Upto High School	32.5	25	36.5	6.0
College and above	—	50	50	—
Paternal Education				
Illiterate	22.5	37.5	34.5	4.5
Upto High School	35	24.5	35	5.5
College and above	44	18.5	25	12.5
Per Capita Income (Rs)				
≤200	29	31.5	34	5.5
201-500	42	14	38	6
>500	33	67	—	—
Caste				
Upper	26.5	26.5	26.5	20.5
Lower	34.5	29.5	30.5	5.5
SC/ST	29.5	27.5	39.5	3.5

initiated breast-feeding after 48 hours. The local customs were the main reasons for delayed feeding in both urban and rural areas. Bahl and Kaushal (1987) found 91.7% rural infants of Himachal Pradesh were put to breast within 24 hours of birth. It is a common practice among rural women in and around Bangalore city to deprive children of breast-milk during the first 2-5 days of their life (Shariff and Farsana, 1990).

Results of two surveys conducted at an interval of a decade in Chandigarh revealed that a higher percentage of mothers in 1984 (64%) as against 24% in 1974 started giving breast-milk within 24 hours of birth and 31% mothers delayed breast-feeding for 48 hours in the belief that they had to wait till sufficient milk started flowing

It is now widely held that the infant should be put to breast after birth as soon as possible when the mother recovers from the immediate physical exhaustion of labour and delivery.

Several studies have shown that mothers who start to breast-feed immediately after delivery continue to breast-feed longer-usually about twice as long (Leefsma and Habatsky, 1980).

Duration of Breast-feeding and Related Practice

"Breast-feed as long as possible" has always been considered to be a good advice. But how long do Indian mothers breast-feed their children ? Throughout history the duration of breast-feeding has varied enormously from 0 to 15 years. The process of lactation has received little attention from historians and anthropologists, and the little we know gives no clue as to what is natural or what should be the ideal duration of breast-feeding (Helsing and King, 1984).

Breast-cleaning Before Feeding

About 92.5% of industrial, 95% of urban and 100% of rural mothers did not clean their

breasts before feeding (Table 3). Only 7.5% and 5% industrial and urban educated mothers cleaned their breasts before feeding. Agarwal et al. (1986) have reported that the percentage of women cleaning their breasts was between 26 and 48% and the practice of breast-cleaning improved with materal education.

It is necessary to have washing of the breasts and nipples and plain water, preferably boiled, should be used for such cleaning. Soap or lotions which contain alcohol is avoided as these substances remove the natural oils and make the skin too dry.

Maternal Posture During Feeding

Babies are fed differently in different cultures, but in Indian a vast majority, particularly at night, prefer to feed the baby lying down (Ghosh, 1976). Often both the mother and the baby go off to sleep after the feed. After the first few weeks, the sitting position is preferred, the baby lying on the mother's lap and her elbow supporting the head. Once the baby learns to sit, he very often feeds while sitting on the mother's lap or on the floor or ground next to her. In all these positions the baby can be fed satisfactorily provided he has easy access to the breast and the mother is relaxed and not in hurry. The less inhibition a mother has about the place and the environment of feeding, the more successful is the breast-feeding (Ghosh, 1976).

Table 3: Per cent distribution of mothers cleaning their breasts before feeding

Particular		*Industrial*	*Urban*	*Rural*
Whether cleaning breast before each feed?	Yes	7.5	5	0
	No	92.5	95	100

In the present study 82% of industrial mothers, 64% of urban and 88.5% rural mothers fed their babies in lying as well as sitting positions (Table 4). In Jammu, 38% of the urban and 33% of the rural mothers used predominantly the lying position and 24% urban and 47% of the rural mothers fed their infants in the propped up position mostly (Sharma and Lahori, 1977). Thaman and Manchanda (1968) found that the position adopted by the mothers during feeding was variable. While 35% of the mothers fed their infants in a squatting position, 63% did so both sitting and/or lying, varying their position with the times of feeding, circumstances and their personal convenience. Occasionally a mother was noted to feed her baby quite comfortably even when walking.

Thus it is very important to check whether or not a mother is relaxed and comfortable in her position irrespective of the type of posture during feeding and whether the particular position allows the breast to fall towards the baby. Helping a mother to find a comfortable position is an important job of the health workers and experienced women available nearby.

Table 4: Distribution of mothers with different maternal posture during breast-feeding

Particulars	*Industrial*	*Urban*	*Rural*
	No. of mothers (% in parentheses)		
Maternal Posture			
Lying	9(5.0)	20(7.0)	19(8.0)
Sitting	24(13.0)	79(29.0)	27(11.5)
Both lying and sitting	150(82.0)	175(64.0)	189(80.5)

Breast-feeding Schedule

Breast-feeds may be given either on demand, *i.e.* whenever a child cries indicating hunger or may be given on the basis of regular time schedule. The current advice is to feed on demand (Gopujkar et al., 1984). The present observation showed that 41, 13 and 54 per cent of the hospital-delivered infants and 48, 36.5 and 81.5 per cent of the homedelivered infants were on demand-feeding in industrial, urban and rural areas, respectively. There was a higher proportion of infants from demand-feeding