

Placental enzyme polymorphism among Maharashtrians: Alkaline phosphatase and lactate dehydrogenase

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Summary. The distribution of placental alkaline phosphatase and lactate dehydrogenase types in 635 placentas from various endogamous groups of Maharashtra have been studied by starch gel electrophoresis. In the case of alkaline phosphatase, 6 common phenotypes and 6 rare phenotypes (F_2I_1 , S_1S_2 , S_2S_3 , I_1S_2 , F_1S_2 , F_1I_2) are encountered. The highest frequency of Pf^{1a} allele (0.7394) and lowest frequency of Pf^{1b} allele (0.0246) have been found in the Nava-Budha. 6 cases of Cal-1 and 5 cases of Cal-2 types of LDH variants have been observed in the total samples, and Muslims possess the highest frequency of Cal-1 types (3.64%). Population groups are compared with respect to Pf alleles.

1. Introduction

Very little is known about the distribution in India of the considerable polymorphism which has been detected in placental alkaline phosphatase (E.C.3.1.3.1.) (Robson and Harris, 1967; Blake *et al.*, 1969 a; Das *et al.*, 1970, 1974) and placental lactate dehydrogenase (LDH E.C.1.1.1.) (Das *et al.*, 1972). The aim of this contribution is to help remedy this deficiency.

2. Materials and methods

The present study was undertaken in Maharashtra during 1973-74 among various endogamous groups of Marathi-speaking people. A total of 630 placenta samples were collected from the following groups: Brahmin (51), Marathas (208), some mixed "middle castes" (46), Nava Budha (Mehtar) (142), some mixed "low castes" (41), Muslims (54) and other non-Marathi-speaking Indians (88). According to the traditional caste hierarchy followed in Maharashtra, the above groups may be ranked as follows: the Brahmins represent the higher caste, the Marathas belong to middle castes and the Nava Budha is a scheduled caste. Besides these major caste groups, many other castes in small numbers come into the sampling and, for convenience of analysis, they are broadly classified into two caste groups—"middle castes" (Dhangars, Mali, Sali, Shimpi, Nahvi, Koshti, Parit, Gosavi, Teli, Lohar, Kali, Sonar, Sutar, Kumbhar, Bhandari etc.) and "low castes" (Chambhar, Wadars,

Population	No. tested	Common phenotypes										Rare phenotypes										χ^2 D.F. 12						
		S ₁ S ₁		F ₁ F ₁		I ₁ I ₁		S ₁ F ₁		S ₁ I ₁		F ₁ I ₁		S ₁ S ₂		F ₁ S ₂		I ₁ S ₂		F ₁ I ₂			F ₁ I ₂					
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%		N	%	N	%		
Brahmin	51	24	47.06	2	3.92	0	0.00	21	41.18	3	5.88	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.96	4.335
Maratha	208	105	50.48	13	6.25	1	0.48	61	29.33	19	9.13	6	2.89	2	0.96	0	0.00	1	0.48	0	0.00	0	0.00	0	0.00	0	0.00	4.908
Middle caste	46	28	60.87	4	8.69	3	6.52	7	15.22	2	4.35	0	0.00	2	4.35	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	35.008
Nava Buddha (Mahar)	142	78	54.93	6	4.22	0	0.00	47	33.10	7	4.93	0	0.00	0	0.00	0	0.00	1	0.70	0	0.00	0	0.00	0	0.00	0	0.00	5.956
Low caste	41	17	41.46	4	9.76	0	0.00	16	39.02	3	7.32	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	2.44	0	0.00	19.961
Muslim	54	28	51.86	1	1.85	2	3.70	14	25.93	5	9.26	1	1.85	2	3.70	1	1.85	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2.768
Others	88	46	52.27	2	2.27	2	2.27	30	34.09	4	4.55	4	4.55	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10.789

Table 1. Placental alkaline phosphatase phenotype distributions in various populations of Maharashtra.

Bhoi, Gurav, Bhangi, Mang, Rameshi, Harijan etc.). The position of the Muslims is self-explanatory. All these samples were collected from B.J. Medical College and Sasson Hospital, and Bhidya Maternity Home in Poona.

The preparation of placental tissue extract and the starch gel electrophoresis technique for both alkaline phosphatase and LDH were performed as described by Blake *et al.* (1969 a, b).

3. Results and discussion

Phenotypes (alkaline phosphatase)

The distribution of the various phenotypes in the different population groups are listed in Table 1. Expected phenotype numbers in each group are calculated assuming Hardy-Weinberg equilibrium and the χ^2 values are given in the same table. From these values it is clear that in all the groups there is close agreement between the expected and the observed distribution, except in the mixed middle castes; where the value is significantly high ($\chi^2 = 35.008$); this may be due to the heterogeneous composition of the group.

In all the groups, five out of the six common phenotypes are observed. The I_1I_1 type is not found in the Brahmin, the Nava Budha and the low castes, but is present in all the other groups. Five rare phenotypes S_1S_1 , S_2S_2 , F_2I_1 , F_2S_2 and I_1S_2 have been found sporadically. In addition, a new phenotype, which has been identified as F_1I_2 , corresponding to another rare allele PI^{12} , has also been encountered in the Brahmin group (one case in a sample of 51). The I_2 electrophoretic band in F_1I_2 pattern is slower than the I_1 band but definitely faster than the S_1 band.

In most of the groups approximately 50% are homozygous S_1S_1 type; the exceptions are the mixed "middle castes" (60.87%) and mixed "low castes" (41.46%). Next in order of preponderance in all the groups is the heterozygote S_1F_1 .

Gene frequencies

Gene frequencies are calculated by the gene counting method and Table 2 presents the distribution in the various groups. The three common alleles PI^{11} , PI^{12} and PI^{13} are present in all the groups and the most widely distributed allele PI^{11} ranges between 0.7394 (Nava Budha) and 0.6463 (mixed "low castes"). Rare alleles PI^{14} , PI^{15} , PI^{16} and PI^{17} have also been detected in very low frequencies. The homogeneity between the population groups has been tested by considering the actual gene count

Population	Common alleles			Rare alleles				Total
	PI^{11}	PI^{12}	PI^{13}	PI^{14}	PI^{15}	PI^{16}	PI^{17}	
Brahmins	0.7059	0.2549	0.0294	0.0000	0.0000	0.0000	0.0098	1.0000
Marathas	0.7010	0.2170	0.0660	0.0160	0.0000	0.0000	0.0000	1.0000
Middle castes	0.7134	0.1431	0.0771	0.0664	0.0000	0.0000	0.0000	1.0001
Nava Budhas	0.7394	0.2324	0.0246	0.0035	0.0000	0.0000	0.0000	0.9999
Low castes	0.6463	0.2927	0.0488	0.0000	0.0000	0.0122	0.0000	1.0000
Muslims	0.6890	0.1500	0.0900	0.0620	0.0090	0.0000	0.0000	1.0000
Others	0.7159	0.2159	0.0682	0.0000	0.0000	0.0000	0.0000	1.0000

Table 2. Placental alkaline phosphatase gene frequencies in various populations of Maharashtra.

of the alleles instead of the absolute phenotype or the genotype frequencies. From Table 3 it appears that the frequencies of Pf^1 gene count is very small in all the population groups and the rare alleles are also too small for any valid comparison. In order to determine the homogeneity between the population groups, parallel sample chi-square tests have been performed based on the gene counts of Pf^1 allele, Pf^2 allele and the sum total of the Pf^1 allele and all the rare alleles. It is seen that even when the gene count of the alleles Pf^1 and all the rare alleles were added together, the total frequencies of this class were not large for all the population groups and five significant chi-square values (with 2 d.f.) were obtained. We have, therefore, attempted two other series of parallel sample tests as follows. The first series based on the gene count of the alleles Pf^1 and the gene count of all the other alleles (i.e. Pf^2 , Pf^3 , and rare alleles) added together, and the second was based on the gene count of Pf^1 and the gene count of all other alleles (i.e. Pf^2 , Pf^3 and rare alleles). The χ^2 values with 1 d.f. are given in Table 4.

Population	Pf^1 count	Pf^2 count	Pf^3 count	All rare alleles count	Total
Brahmin					
Obs.	72	26	3	1	102
Exp.	72.54	22.68	5.64	1.13	101.99
Maratha					
Obs.	292	93	28	3	416
Exp.	295.88	92.49	23.03	4.60	416
Middle caste					
Obs.	67	15	8	2	92
Exp.	65.44	20.45	5.09	1.01	91.99
Nava Budha					
Obs.	210	66	7	1	284
Exp.	201.99	63.14	15.72	3.14	283.99
Low caste					
Obs.	53	24	4	1	82
Exp.	58.32	18.23	4.54	0.91	82.00
Muslim					
Obs.	77	17	10	4	108
Exp.	76.82	24.01	5.88	1.19	108

Table 3. Distribution of Pf alleles by gene count method in various populations of Maharashtra.

From the chi-square values obtained by the above method, it may be concluded that (1) there is not much heterogeneity among the groups for different Pf gene counts; (2) significant differences are noticed only when the Muslims are compared with Nava Budhas, the "low caste" and the Brahmin groups for Pf^1 , Pf^2 and the "remainder" alleles ($\chi_1^2 = 16.50, 6.45$ and 7.44 respectively); (3) similarly, the Nava Budhas also differ from the Marathas and the "mixed" middle castes ($\chi_1^2 = 6.89$ and 10.97 respectively); (4) significant variation is also revealed when the low caste group is compared with the "mixed" middle caste and the Muslims with respect of Pf^1 and the "remainder" alleles ($\chi_1^2 = 4.19$ and 5.04 respectively); (5) but complete homogeneity is found amongst all the groups when compared for Pf^2 and the "remainder" alleles.

Lactate dehydrogenase

LDH isozymes were typed against known control variants and the distributions of various LDH variants, and their gene frequencies are given in Table 5. The incidence of Cal-1 type, which is a faster A-sub-unit variant, has been noticed in the Nava Budha (about 2%) and the Muslims (about 2.6%) and other non-Maharashtrians (about 1%). But the Cal-2 variant (much faster A-sub-unit variant) is present in the Brahmins, the Marathas, the "middle caste" and the Nava Budhas in relatively low frequencies (1-2%).

Population	χ^2 test for Pf^{11} , Pf^{12} and all other alleles count (2 d.f.)	χ^2 test for Pf^{11} , and all other alleles count (1 d.f.)	χ^2 test for Pf^{11} , and all other alleles count (1 d.f.)
BRA x MAR	1-8631	0-0061	0-4548
BRA x MID	5-2008	0-1192	2-4488
BRA x NAV	0-5697	0-4292	0-2094
BRA x LOW	0-9160	0-7397	0-3278
BRA x MUS	7-4417†	0-0127	3-0621
MAR x MID	2-4619	0-2521	1-6480
MAR x NAV	6-8972†	1-1708	0-0750
MAR x LOW	1-8724	0-9942	1-8209
MAR x MUS	4-8344	0-0501	2-2621
MID x NAV	10-9758‡	0-0447	1-9773
MID x LOW	4-8181	1-3594	4-1901†
MID x MUS	0-2074	0-0576	0-0117
NAV x LOW	3-6359	2-7269	1-2471
NAV x MUS	16-5049‡	0-2796	2-6361
LOW x MUS	6-4519†	0-9574	5-0403†

† Significant at 5% level, but insignificant at 1% level.

‡ Significant at 0.1% level.

BRA = Brahmin, MAR = Maratha, NAV = Nava Budha, MID = Mixed middle caste, LOW = Mixed low castes, MUS = Muslim.

Table 4. Inter-group comparison with respect to *Pf* allele gene count amongst various populations of Maharashtra.

Population	tested	Phenotype			Gene frequencies		
		Normal	Cal-1	Cal-2	LDH ^N	LDH ^{Cal-1}	LDH ^{Cal-2}
Brahmin	N	49	48	0	1		
	%		97-96		2-04	0-9898	0-0000
Maratha	N	209	209	0	1		
	%		99-52		0-48	0-9976	0-0000
Middle castes	N	47	46	0	1		
	%		97-87		2-13	0-9893	0-0000
Nava Budhas	N	144	139	3	2		
	%		96-53	2-08	1-39	0-9826	0-0104
Low castes	N	41	41	0	0		
	%					1-0000	0-0000
Muslims	N	55	53	2	0		
	%		96-36	3-64		0-9818	0-0182
Others	N	90	89	1	0		
	%		98-89	1-11		0-9945	0-0056

Table 5. Distribution of lactate dehydrogenase types and gene frequencies in various populations of Maharashtra.

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Zusammenfassung. Die Verteilung der Typen der placentalen Alkali-Phosphatase und Lactat-Dehydrogenase wurde bei 635 Plazenten von verschiedenen endogamen Gruppen von Maharashtra durch Stärkegel-Elektrophorese untersucht. Bei der Alkalin-Phosphatase wurden 6 übliche Phänotypen und 6 seltene Phänotypen (F_1I_1 , S_1S_2 , S_2S_3 , I_1S_2 , F_1S_2 , F_1I_2) gefunden. Die höchste Frequenz des Allels PI^1 (0,7394) und die niedrigste Frequenz von PI^2 (0,0246) wurden bei dem Nava-Budha gefunden. Sechs Fälle von Cal-1 und fünf Fälle von Cal-2 wurden bei den LDH-Varianten in der gesamten Stichprobe gefunden, und die Moslems besitzen die höchste Häufigkeit des Typs Cal-1 (3,64%). Ein Vergleich zwischen Bevölkerungsgruppen wurde für das Allel PI durchgeführt.

Résumé. La distribution des types de phosphatase alcaline et de lactate déshydrogénase placentaires a été étudiée dans 635 placentas provenant de divers groupes endogames de Maharashtra par électrophorèse sur gel d'amidon. Dans le cas de la phosphatase alcaline, 6 phénotypes communs et 6 phénotypes rares (F_1I_1 , S_1S_2 , S_2S_3 , I_1S_2 , F_1S_2 , F_1I_2) sont rencontrés. La fréquence la plus élevée de l'allèle PI^1 (0,7394) et la plus basse de l'allèle PI^2 (0,0246) ont été trouvées chez les Nava-Budha. Six cas de types Cal-1 et 5 cas de Cal-2 des variantes de LDH ont été observés dans les échantillons totaux, et les Musulmans ont la fréquence la plus élevée des types Cal-1 (3,64%). La comparaison a été faite entre les groupes de populations en ce qui concerne les allèles PI .