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Inbreeding Load in Whites and Negroes

A Reappraisal

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SUMMARY

A reanalysis is made of the data obtained in two surveys in Brazil, regarding the inbreeding load of Whites and Negroes. It is shown that the differences detected are probably spurious, and mainly due to environmental factors. The " total " inbreeding load estimated for the pooled sample showed nonsignificant difference between Whites and Nonwhites.

A number of papers have been published in the last decade regarding the effect of consanguineous marriages on mortality and morbidity. On the basis of these data, estimates of inbreeding loads have been obtained for a number of populations. The estimates obtained in the State of Minas Gerais (Brazil) are particularly interesting, because the inbreeding load seemed to be quantitatively different in Negroes and Whites (Freire-Maia, 1963; Freire-Maia et al, 1963).

A survey made in the same area, but using sib controls (Azevedo and Freire-Maia, 1970), as well as surveys made in the States of Bahia (Quelce-Salgado and Martello, 1969) and Espirito Santo (Freire-Maia, 1970a) did not confirm the previous findings and clearly indicated that Whites and Negroes from the areas studied have inbreeding loads of the same magnitude.

Since the first two surveys in Minas Gerais led to the same general conclusion regarding inbreeding load and ethnic groups, it seems interesting to present a brief comparative evaluation of the results obtained in both surveys, and to analyse the pooled data on inbreeding effects. Since the results obtained in these two surveys were not confirmed, it seems also interesting to present some tests of internal consistency of the data, in an attempt to explain the situation.

Comparative Analysis of Both Surveys

MATERIAL AND METHODS

In the first survey (Freire-Maia et al, 1963), 1110 families from a predominantly rural area have been interviewed by the authors. The areas, which are part of three contiguous *municipios* in the South of the State of Minas Gerais, have been chosen mainly be-

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cause of the relatively high inbreeding levels of their lower socio-economic classes, which alone have been surveyed. Families have been grouped into three categories according to the appearance of each spouse (White, Mulatto, or Negro). The Whites are almost entirely members of families of distant Portuguese origin.

In the second survey, 1926 families from a predominantly urban area have been interviewed by women duly instructed, under the author's supervision. This sample also includes low socio-economic classes from other areas of the same geographical zone previously studied (see map in Freire-Maia, 1963). Since in this survey no efforts were made to minimize the social distance between Negroes and Whites, it is expected that, differently from the first survey, Whites would present a little better mean social position than Negroes. Inbreeding rates in this survey were found to be appreciably lower than in the first one. Owing to the smallness of some consanguineous subsamples, families have been grouped into only three categories according to the appearance of each spouse (White, W, or Nonwhite, NW, where Nonwhite stood for Mulatto or Negro). As previously, Whites were almost entirely members of families of distant Portuguese origin.

The Data

1. MEAN MARRIAGE AGE. In the first survey, the differences between consanguineous and control samples are not statistically significant. In the second sample, however, consanguineous parties marry, on the average, 1-2 years younger than control couples.

2. MEAN " COHABITATION TIME " (mean time from marriage to the survey). It is consistently higher in the consanguineous groups (in the first survey, however, the differences are not significant).

3. ILLITERACY. The rates of illiteracy are very high in the populations analysed, and increased from W $\times$ W to NW $\times$ NW. Illiteracy has been defined under two criteria: (1) lack of even the most elementary knowledge of writing and reading; (2) the precedent, plus a very inadequate knowledge of writing and reading. Under both criteria, consanguineous W $\times$ W couples present a systematically *lower* frequency of illiteracy (significant in only one instance, second survey, criterium 1). Consanguineous NW $\times$ NW couples present an opposite picture, i. e., a systematically higher frequency of illiteracy (significant under criterium 2, and under both criteria for the totals of the two surveys). W $\times$ NW couples present an intermediary situation (under criterium 1, consanguineous couples present a nonsignificantly lower frequency of illiteracy; whereas, under criterium 2, they present an opposite picture, the differences being significant in the first survey, and in the total of both surveys).

4. FECUNDITY (mean number of pregnancy terminations per woman with at least one). It is consistently higher (significantly only in the second survey) among the consanguineous couples than among the nonconsanguineous ones. Probably this difference may be understood by differences in " cohabitation time ".

5. MORTALITY. The differences in mortality rates in the first survey, as well as the differences in the rates of abortions plus miscarriages in the second survey, are not statistically significant among the several control subsamples. In the second survey, Nonwhite controls present the highest mortality rates revealed as stillbirths, postbirth mortality, and " total ". (The pooled data are presented in Tab. I).

Discussion

On the basis of the data on mortality rates, estimates of genetic loads have been made. The conclusion has been reached, in both surveys, that the results are consistent with the hypothesis that Whites present a small load of mutations (namely, less than 1 lethon), whereas Negroes present a heavier load (around 4 lethons).

Several extraneous concomitant variables which could distort the results have been duly analysed, but no suggestion of a differential effect has been reached. Mortality rates in the different control subsamples, for instance, were found to be rather similar in the first survey (Tab. II), the differences between them being nonsignificant (Freire-Maia et al, 1963). The significant differences detected in the second survey (Tab. II) were ascribed to the fact that, in this survey, Whites were expected to have a little better mean socio-economic position than Nonwhites (Freire-Maia, 1963).

If, due to factors of possible nongenetic origin, mortality rates in the Nonwhite controls were found to be *lower* than in the White controls, then there would be some reason to suspect that the estimates of inbreeding loads were biased (this theoretical situation would lead to the biased estimate of a relatively " high " load among Nonwhite in comparison to a relatively " low " one among Whites). However, Nonwhite controls presented *higher* mortality rates than did White controls, which disagrees with the possibility outlined.

In the analysis of the pooled data from both surveys (Tab. II), the same conclusion has been reached. Although NW $\times$ NW couples presented a significantly lower frequency of abortions plus miscarriages than did W $\times$ W and W $\times$ NW couples taken separately or together — what could be taken as explaining the heavier inbreeding load detected among Nonwhites — the situation in stillbirths and mortality after birth did not show the same picture. Regarding stillbirths, NW $\times$ NW couples showed significantly higher rates than did W $\times$ W or W $\times$ NW, taken separately or together, although its estimated genetic load is not consistently lower. Regarding mortality after birth, the differences between W $\times$ W and NW $\times$ NW couples are not significant; however, in all the situations, NW $\times$ NW couples revealed inbreeding loads higher than those estimated for W $\times$ W couples. Therefore, differences in the mortality rates of the control subsamples, taken alone, are not the cause of the differential inbreeding load of Whites and Nonwhites.

As pointed out previously, illiteracy rates increases from Whites to Nonwhites both in the control and the consanguineous subsamples. As shown in Tab. III and Fig. 1, which represent the pooled data from both surveys, whereas in Whites the

Tab. I. Mortality in the pooled samples

Couples	Abortions plus miscarriages			Stillbirths			Mortality after birth			Total		
	F	N	n	*F*	N	n	*F*	N	n	*F*	N	n
W × W	0.000000	6999	792	0.000000	6269	189	0.000000	6080	1094	0.000000	6999	2075
	0.015625	363	55	0.015625	314	4	0.015625	310	52	0.015625	363	111
	0.030586	318	35	0.030626	288	15	0.030592	273	50	0.030586	318	100
	0.061985	698	66	0.061887	638	21	0.061867	617	118	0.061985	698	205
	0.093847	160	23	0.095222	138	4	0.094333	134	33	0.093847	160	60
W × NW	0.000000	3300	377	0.000000	2959	107	0.000000	2852	575	0.000000	3300	1059
	0.015625	29	2	0.015625	28	1	0.015625	27	6	0.015625	29	9
	0.023437	118	16	0.024188	104	1	0.024271	103	14	0.023437	118	31
	0.031250	42	3	0.031250	39	2	0.031250	37	7	0.031250	42	12
	0.069240	153	17	0.069419	140	10	0.068990	130	30	0.069240	153	57
NW × NW	0.000000	5796	568	0.000000	5297	233	0.000000	5064	975	0.000000	5796	1776
	0.015625	111	16	0.015625	97	6	0.015625	91	12	0.015625	111	34
	0.031250	205	44	0.031250	163	9	0.031250	154	37	0.031250	205	90
	0.061863	276	44	0.062248	233	9	0.064907	224	69	0.061863	276	122
	0.090909	22	3	0.090461	19	2	0.089154	17	7	0.090909	22	12

SOURCE: Freire-Maia et al, 1963 (First survey), and Freire-Maia, 1963 (Second survey).

Tab. II. Mortality rates in the control subsamples ($F = 0$)

Classes [a]	Couples	First survey		Second survey		Total	
		N	Freq.	N	Freq.	N	Freq.
Abt	W × W	2375	0.1040	4624	0.1179	6999	0.1132
	W × NW	1137	0.1152	2163	0.1137	3300	0.1142
	NW × NW	1940	0.0881	3856	0.1030	5796	0.0980
Stb	W × W	2158	0.0385	4111	0.0258	6269	0.0301
	W × NW	1014	0.0424	1945	0.0329	2959	0.0362
	NW × NW	1789	0.0402	3508	0.0459	5297	0.0440
Mab	W × W	2075	0.1971	4005	0.1710	6080	0.1799
	W × NW	971	0.1874	1881	0.2089	2852	0.2016
	NW × NW	1717	0.1928	3347	0.1924	5064	0.1925
Tot	W × W	2375	0.3112	4624	0.2889	6999	0.2965
	W × NW	1137	0.3131	2163	0.3250	3300	0.3209
	NW × NW	1940	0.2959	3856	0.3117	5796	0.3064
	Total	5452	0.3061	10643	0.3045	16095	0.3051

SOURCE: Freire-Maia et al, 1963 (First survey), and Freire-Maia, 1963 (Second survey).
[a] Abt = Abortions plus miscarriages; Stb = Stillbirths; Mab = Mortality after birth; Tot = Total.

rates of illiteracy are lower in the consanguineous than in their corresponding controls, in Nonwhites the rates of illiteracy are much larger in the consanguineous than in their controls. If illiteracy rates are accepted as indicators of socio-economic levels, the conclusion can be reached that the relatively high mortality rates among inbred individuals from Nonwhite parents could better be ascribed, at least in part, to their poor living conditions. On the other side, the small inbreeding effect detected among Whites is probably spurious, as a result of better socio-economic conditions of the consanguineous couples. However, these conclusions would be based on a doubtful correlation between illiteracy rates and socio-economic levels. For instance, although there are large differences in illiteracy rates in the different control subsamples from the first survey, their mortality rates show small differences which are not statistically significant. In a special survey of NW $\times$ NW families, it has been found that the consanguineous couples were apparently in a better situation than non-consanguineous ones in 9 out of 11 aspects studied (quality of houses, salaries, living conditions, health, ownership, savings, etc.; cf. Freire-Maia et al, 1963).

In order to test the possibility that some undetected environmental factor is acting differently in the inbred and control groups, we made some tests for internal consistency of the data. In Tables IV-VI estimates of the expressed damage in the class with $F = 0$ (A) and of the number of lethons (B and B_{FF}) have been made through a new method by Freire-Maia (1970b). (See Freire-Maia and Freire-Maia, 1965). The regression coefficients B were obtained by using the whole set of data, whereas in the estimates of B_{FF} the class with $F = 0$ has been omitted. As can be seen (Tables IV to VI), there is a good agreement between the estimates of B and B_{FF}. This confirms that mortality rates in the control subsamples do not account for the different estimates of inbreeding load.

As shown in Tab. VII, the difference in the " total " inbreeding loads of Whites and Nonwhites is questionable. In the first place, the differences detected are significant only when the whole data are used (B), being nonsignificant when one compares the estimates obtained only through the consanguineous subsamples (B_{FF}). In the second place, the significant differences detected in the first and the second surveys turned out to be nonsignificant in the pooled data, both for the estimates of B and B_{FF} (see Tab. VII).

Although the differences in the " total " loads from the pooled data of Whites and Nonwhites are nonsignificant (Tab. VII), partition of the analysis showed a consistently significant difference in the load revealed as mortality after birth, besides a questionable significant difference in the load revealed as abortion (Tab. VIII). It is to be noted that the heavy " total " load detected in Nonwhites is mainly due to a heavy load expressed as mortality after birth (see the estimates of B and B_{FF} in Tab. VI).

Taking into consideration that mortality after birth is highly dependent on environmental factors, and considering also that probably there is a decline in socio-economic levels with increasing inbreeding in Nonwhites, and an opposite situation in Whites, a working hypothesis should be presented, namely that the estimates of

Tab. III. Illiteracy rates among the pooled parties

Parties		N	Illiteracy [a (1)] %	Illiteracy [a (1)] χ^2	Illiteracy [a (2)] %	Illiteracy [a (2)] χ^2
W × W	control	2171	35.33	2.17	51.50	0.20
	consang.	439	31.66		50.34	
W × NW	control	1095	47.95	0.06	61.46	3.56
	consang.	109	46.79		70.64	
NW × NW	control	1984	55.70	4.04*	70.16	20.19***
	consang.	188	63.30		85.64	

SOURCE: Freire-Maia et al, 1963 (First survey), and Freire-Maia, 1963 (Second survey).
[a (1)] A complete lack of even the most elementary knowledge of writing and reading;
[a (2)] The precedent plus a very deficient knowledge of writing and reading.

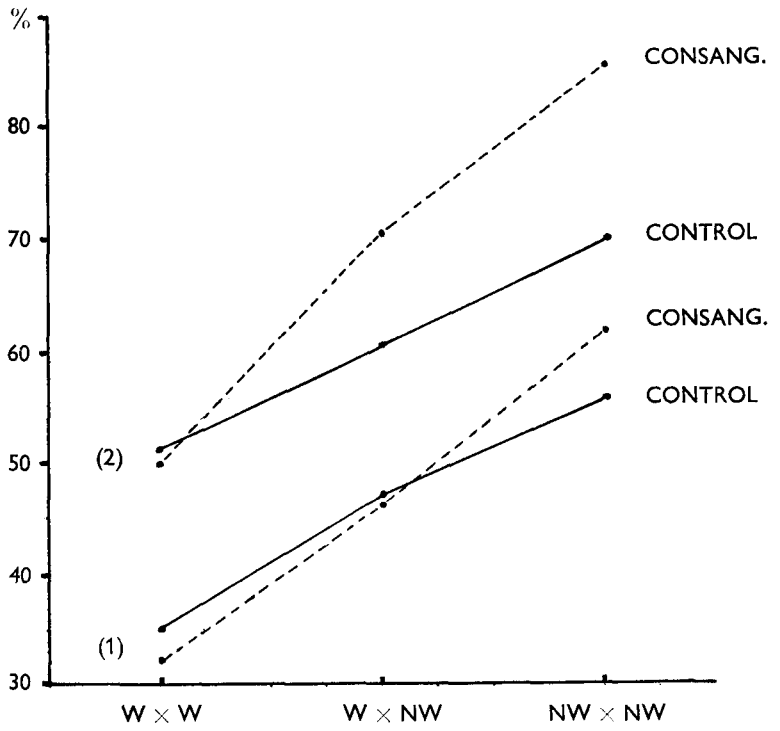

Fig. 1. Illiteracy rates as in Tab. III

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Tab. IV. Inbreeding loads (1)

Couples	Classes [a]	A	B [b]	B_{FF} [c]	t [d]
W × W	Abt	0.106	—0.187 ± 0.298	—0.744 ± 0.513	0.94
	Stb [e]	0.037	0.239 ± 0.335	0.871	
	Mab	0.194	0.044 ± 0.430	1.189 ± 0.501	1.73
	Tot	0.309	0.065 ± 0.672	1.073 ± 1.526	0.60
W × NW	Abt	0.114	—0.670 ± 0.356	0.020 ± 0.786	0.80
	Stb	0.042	0.728 ± 0.419	1.065 ± 0.913	0.34
	Mab	0.188	0.881 ± 0.269	0.740 ± 0.624	0.21
	Tot	0.312	0.967 ± 0.869	1.653 ± 2.055	0.31
NW × NW	Abt	0.089	1.530 ± 0.560	0.768 ± 1.240	0.56
	Stb	0.041	0.215 ± 0.359	—0.262 ± 0.804	0.54
	Mab	0.191	1.839 ± 0.995	3.925 ± 1.992	0.94
	Tot	0.295	3.719 ± 0.972	4.899 ± 2.256	0.48

SOURCE: Freire-Maia et al, 1963 (First survey).
[a] See note to Tab. II.
[b] Estimates using the whole set of data.
[c] Estimates excluding the class with $F = 0$.
[d] Comparisons between B and B_{FF}.
[e] Only two classes of F were available.

Tab. V. Inbreeding loads (2)

Couples	Classes [a]	A	B [b]	B_{FF} [b]	t [b]
W × W	Abt	0.119	0.019 ± 0.496	—0.329 ± 1.159	0.28
	Stb	0.026	—0.051 ± 0.179	—0.113 ± 0.445	0.13
	Mab	0.171	0.589 ± 0.208	0.711 ± 0.498	0.23
	Tot	0.290	0.591 ± 0.704	0.156 ± 1.680	0.24
W × NW	Abt	0.115	0.143 ± 0.957	—0.796 ± 2.191	0.39
	Stb	0.032	0.070 ± 0.327	0.561 ± 0.599	0.72
	Mab	0.207	—0.426 ± 1.639	0.572 ± 4.766	0.20
	Tot	0.323	0.008 ± 2.631	0.483 ± 7.420	0.06
NW × NW	Abt	0.104	2.038 ± 1.699	2.944 ± 2.651	1.58
	Stb	0.046	0.001 ± 0.062	0.018 ± 0.220	0.07
	Mab	0.192	2.671 ± 0.704	4.512 ± 1.000	1.51
	Tot	0.312	4.603 ± 0.995	2.043 ± 1.891	1.20

SOURCE: Freire-Maia, 1963 (Second survey).
[a] See note to Tab. II.
[b] See notes to Tab. IV.

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Tab. VI. Inbreeding loads (3)

Couples	Classes [a]	A	B [b]	B_{FF} [b]	t [b]
W × W	Abt	0.114	—0.052 ± 0.318	—0.375 ± 0.723	0.41
	Stb	0.030	0.056 ± 0.157	0.125 ± 0.392	0.16
	Mab	0.179	0.407 ± 0.222	0.895 ± 0.334	1.22
	Tot	0.296	0.424 ± 0.375	0.513 ± 0.908	0.09
W × NW	Abt	0.114	—0.063 ± 0.310	—0.035 ± 0.800	0.03
	Stb	0.036	0.368 ± 0.295	1.041 ± 0.568	1.05
	Mab	0.200	0.199 ± 0.643	1.711 ± 1.201	1.11
	Tot	0.319	0.643 ± 0.815	2.968 ± 0.856	1.97
NW × NW	Abt	0.099	1.697 ± 0.783	—0.652 ± 1.101	1.74
	Stb	0.044	0.092 ± 0.196	—0.154 ± 0.526	0.44
	Mab	0.191	2.240 ± 0.697	4.332 ± 0.983	1.74
	Tot	0.306	4.590 ± 2.110	5.470 ± 5.359	0.15

SOURCE: data in Tab. I.
[a] See note to Tab. II.
[b] See notes to Tab. IV.

Tab. VII. Statistical analysis of the differences in the total inbreeding loads of Whites and Nonwhites

Comparisons	Tab. IV		Tab. V		Tab. VI	
	t_B	$t_{B_{FF}}$	t_B	$t_{B_{FF}}$	t_B	$t_{B_{FF}}$
(W × W) × (W × NW)	0.82	0.23	0.21	0.04	0.24	1.97
(W × W) × (NW × NW)	3.09***	1.40	3.29***	0.75	1.94	0.91
(W × NW) × (NW × NW)	2.11*	1.06	1.63	0.20	1.74	0.46

Significance: * $P < 0.05$; *** $P < 0.005$.

Tab. VIII. Statistical analysis of the differences in the inbreeding loads of Whites and Nonwhites

	t_B	$t_{B_{FF}}$
Abt	2.07*	0.21
Stb	0.14	0.43
Mab	2.51**	3.31***
Tot	1.94	0.91

NOTE: data derived from the classes W × W and NW × NW in Tab. VI.
Significance: * $P < 0.05$; ** $P < 0.02$; *** $P < 0.005$.

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inbreeding loads for Nonwhites are somewhat inflated, being somewhat underestimated for Whites. This bias is probably due to environmental factors, expressing themselves differently in the consanguineous couples of Whites and Nonwhites.

On the basis of the results and analysis here presented and discussed, there is no reason to suspect that Whites and Nonwhites have inbred loads of different magnitude. A new investigation in the same area, but using siblings as controls, also revealed Whites and Nonwhites with loads of the same order of magnitude (Azevedo and Freire-Maia, 1970). A reanalysis of the whole problem, including new data, confirmed this conclusion (Krieger et al, 1970).

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Riassunto

Viene effettuata una nuova analisi dei risultati di due ricerche riguardanti il peso dell'endogamia in Bianchi e Negri in Brasile. Si dimostra che le differenze riscontrate sono probabilmente spurie e dovute principalmente a fattori ambientali. Il carico endogamico « totale » stimato per il campione complessivo non ha dimostrato differenze significative tra Bianchi e Negri.

Résumé

Une nouvelle analyse a été faite des résultats de deux recherches concernant le poids endogamique des Blancs et Noirs au Brésil. L'on démontre que les différences trouvées sont probablement fausses et principalement causées par les facteurs ambiants. Le poids endogamique « total » estimé pour l'échantillon complexif n'a pas présenté de différences significatives entre Blancs et Noirs.

ZUSAMMENFASSUNG

Erneute Analyse über den Einfluss der Endogamie bei Weissen und Negern in Brasilien. Es wird bewiesen, dass die festgestellten Unterschiede wahrscheinlich gar nicht vorhanden und hauptsächlich durch Umweltsfaktoren bedingt sind. Der " Gesamt " - einfluss der Endogamie ergab in der ganzen Versuchsgruppe keine wesentlichen Unterschiede zwischen Weissen und Negern.

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