Ethnicity and Cancer Risk in São Paulo, Brazil

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Abstract

Data from the São Paulo Cancer Registry (Brazil) for the period 1969–1974 are used to investigate ethnic differentials in cancer risk. Risks for specific cancers were estimated for mulattos and blacks relative to whites, using a case-control approach with other cancers as controls. For both sexes, blacks and mulattos are at higher risk than whites for cancer of the esophagus, stomach, and liver and for myeloma; for prostate cancer in males; and for gall bladder, pancreas, and cervix uteri cancers in females. Blacks and mulattos are at lower risk than whites for cancer of the colon, lung, larynx (males only), bladder, bone, testis, breast, and corpus uteri and for melanoma and leukemia. Except for lung and colon cancers, for which life-style habits are the main risk factors, these ethnic differences are similar to those observed in the United States.

Introduction

Many studies have documented clear differences in cancer incidence between the black and white populations of the United States (1–5). Diverse factors contribute to these racial differences, such as alcohol and tobacco consumption, nutritional status, occupation, obesity, and reproductive attitudes. Differences in exposure to these factors are linked to socioeconomic status, which may therefore be important in explaining the observed cancer patterns, although it is possible that some of the differences between blacks and whites relate to true genetic factors. Comparisons of differences in cancer risk between black and white populations in other parts of the world may help to provide working hypotheses for further investigation. An area of considerable interest in this respect is South America, where blacks have historically been more integrated, in terms of intermarriage and social equalities, than in the United States.

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In São Paulo, ethnic group is recorded for each incident case in the cancer registry, as well as at the time of the census (in 1980, blacks and mulattos represented 4.7 and 19.9%, respectively, of the resident population). However, because there is no standard definition of ethnic group, the incidence rates from São Paulo, as well as from other Brazilian cancer registries, have been published for the population as a whole, rather than being subdivided by ethnic group (6). Although incidence rates cannot be compared, differences in risks between ethnic groups can be estimated using a case-control approach, taking for each specific cancer all other cancer sites as controls (7–8). The purpose of this study is to investigate the relationship between ethnicity and cancer occurrence in São Paulo county, Brazil, using this case-control approach.

Materials and Methods

Data. The data consisted of all invasive incident cancers recorded in the São Paulo cancer registry during the period 1969–1974. The registry, which was established in 1969, is population based, covering the area of São Paulo county (about 7 million inhabitants), and collects data on cancer cases from all of the hospitals, clinics, laboratories, and autopsy services in the area, as well as obtaining copies of all death certificates mentioning cancer (6).

For each incident case, data are recorded on age, sex, civil status, occupation, ethnic group, country of birth, date of diagnosis, site of tumor, histology, and source of information. Although the registry continued to collect data until 1978, only for the first 6 years were all records available on computer. Tumor site, coded according to the 8th revision of the International Classification of Diseases, was recoded according to the 9th revision for analysis (6).

Ethnic group was recorded by the registry in five categories: white, black, mulatto, yellow, and unknown.

Occupation, which had been recorded according to the International Standard Classification of Occupation, was recoded as a social class indicator of 5 levels as follows: high (professional, technical, administrative, executive, and managerial workers); medium (clerical, sales, transport and communication workers, services, sport and recreation occupations, members of armed forces); low (small farmers, laborers, and skilled or unskilled workers); other (unemployed, students, handicapped, and housewives); and unknown.

The 1980 census figures indicated that about 10% of the resident population of São Paulo was not born in Brazil. The main countries of birth were Portugal, Italy, Spain, and Japan. Results on cancer risks in Japanese migrants to São Paulo have been published recently (9–10). Given that about 70% of the cases coded as "yellow"

Table 1 Distribution of cases by sex and ethnic group, São Paulo cancer registry, 1969-1974

Ethnic group	Males		Females	
	No.	%	No.	%
White	28,360	82.0	31,490	80.8
Black	1,100	3.1	1,275	3.2
Mulatto	1,482	4.2	2,044	5.2
Yellow	1,097	3.1	838	2.1
Unknown	2,542	7.3	3,301	8.4
Total	34,581	100	38,948	100

are born in Japan, results for this group were not analyzed.

Statistical Methods. Odds ratios, by ethnic group, were estimated for individual cancer sites by logistic regression, taking incident cases of the specific cancer as cases and using as controls all other cancers. All models were fitted using the Generalized Linear Interactive Modelling System package (11) and were additive on the logarithmic scale. Separate analyses were undertaken for males and females, and ethnicity was coded as white, mulatto, black, yellow, or unknown. Odds ratios were adjusted for age at incidence (0-34, 35-44, 45-49, 50-54, 55-64, 65-74, and 75 years and more), civil status (ever married, other), period (1969-71, 1972-74), histological confirmation (yes, no), death certificate only case (yes, no), country of birth (Brazil-born, other, unknown), and social class (high, medium, low, other, unknown). The significance of each variable was assessed by comparing the goodness of fit measure (deviance) of the model with and without the variable of interest.

Data Quality. Validation of the records was carried out by checking for incompatible sex-site, site-histology, and age-site code combinations. Among all of the 79,229 invasive cases registered during 1969-1974, 5,700 cases (7.2%) were excluded because of unknown age at diagnosis (n = 2,726), unknown or invalid year of diagnosis (n = 1,739), unknown sex (n = 53), sex/site incompatibility (n = 61), invalid values for cause of death (n = 74), and place of residence other than São Paulo county (n = 1,047). Among the remaining 73,529 cases, 71.6% were histologically verified and 10.2% had been registered on the basis of information only from the death certificate of cases. A small number (6.2%) had an ill-defined primary site (International Classification of Diseases, 9th revision, codes 159, 165, 195-99).

Results

The distribution of incident cases by color and sex is shown in Table 1. Color is missing in less than 9% of recorded cases in both sexes. More than 80% of the cases occur among whites. Only 3% of the cases occur among blacks, although this corresponds to more than 1000 cancers in each sex.

A cross-tabulation of social class by sex and ethnic group in cases aged 35-64 is shown in Table 2. Occupation is poorly recorded; more than 30% of cases in males are in the "unknown" category, and 70% of cases in females are in the "other" category, which mainly includes housewives. It is clear, however, that cases among blacks and mulattos are of lower social status than

Table 2 Distribution of cases aged 35-64 by ethnic group and social class (percent), São Paulo cancer registry, 1969-1974

Ethnic group	Social class (% of total)					Total no.
	High	Medium	Low	Other	Unknown	
Males						
White	11.5	17.3	27.6	14.5	28.8	15,546
Black	1.7	12.2	41.0	17.6	27.3	702
Mulatto	2.7	12.8	44.7	15.6	24.0	919
Yellow	18.3	15.7	25.8	8.6	31.4	534
Unknown	1.4	2.4	3.1	2.2	90.7	1,211
Total	10.2	15.9	27.3	13.7	32.5	18,912
Females						
White	3.5	3.0	2.4	75.4	15.4	18,908
Black	0.7	6.0	3.2	72.1	17.7	793
Mulatto	0.4	3.1	2.9	79.8	13.5	1,317
Yellow	2.9	1.9	3.1	77.5	14.3	503
Unknown	0.7	0.8	0.3	11.1	86.9	1,663
Total	3.1	3.0	2.4	71.0	20.5	23,184

cases among whites; conversely, cases among the "yellow" population are of higher social status than among whites.

The distribution of cases by ethnicity and indicators of data quality is shown in Table 3. The quality of records is lower among blacks and mulattos than among whites, particularly among males.

Tables 4 and 5 show, for males and females, respectively, the number of cases and the percentage of unknown ethnicity at each cancer site. After excluding skin cancer, the most common cancer in males is stomach (18.4%) followed by lung (10.8%) and prostatic cancer (6.3%). In females, the most common cancer is breast (23.1%), followed by cervix uteri (18.8%) and stomach cancer (8.5%). The proportion with unknown ethnicity varies from less than 1% for leukemia to more than 11% for melanoma.

Introducing the variables of birthplace and social class into the logistic regression model resulted in a significantly better fit (lower deviance) for most sites, as did the two variables indicating quality. Similarly, the variable civil status was significant for most gynecological cancers. The risk estimates for ethnic group were therefore adjusted for all these variables, in addition to age and period.

The relative risk estimates for blacks and mulattos, using whites as the reference category, are presented for males in Table 4 and for females in Table 5. Most of the estimates for unknown color were close to unity and are not shown in the tables. Sites with fewer than 50 cases are not reported.

Compared to whites, blacks have higher risks for cancers of the esophagus, stomach, prostate, and cervix uteri and for myeloma (statistically significant in males only). On the other hand, blacks have lower risks for cancers of the colon, lung, and bladder and for leukemia (significantly so in males only) and cancer of the breast in females. Risk estimates for melanoma are less than unity among blacks of both sexes, but because of the small numbers (4 cases in each sex) the results are not significant. Compared to whites, blacks also have an increased risk for ill-defined sites of cancer in both sexes, and for "uterus, ill-defined" in females.

Results for mulattos for most sites are quite similar to those found among blacks, although because of

Table 3 Distribution (in percent) of data quality indicators by ethnic group and sex, São Paulo cancer registry, 1969-1974

	White	Black	Mulatto	Yellow	Unknown	Total
Males						
% of HV[a]	68.5	62.6	58.2	57.1	92.5	69.2
% of DCO	11.8	15.0	19.6	18.5	0.7	11.6
% of IDS	6.2	8.2	7.6	7.7	8.8	6.5
No.	28,360	1,100	1,482	1,097	2,542	34,581
Females						
% of HV	63.4	63.6	64.2	68.6	88.7	73.6
% of DCO	9.1	14.1	14.0	11.6	0.3	8.9
% of IDS	5.6	8.7	7.2	4.5	7.2	5.9
No.	31,490	1,275	2,044	838	3,301	38,948

[a] HV, histologically verified cases; DCO, death certificate only cases; IDS, ill-defined site of cancer (International Classification of Diseases, 9th revision, codes 159, 163, 195-9).

greater numbers, more estimates attain statistical significance. Higher risks are found in mulattos than in whites not only for esophagus and stomach cancer (as found for blacks) but also for liver cancer in both sexes and for gall bladder and pancreatic cancer in females. As for blacks, the risks for prostatic and cervical cancer are increased among mulattos. In males, lower risks in mulattos are found not only for lung and bladder cancer (as for blacks) but also for larynx and testis cancers. In females, risks are lower not only for breast cancer (as found for blacks) but also for corpus uteri and bone cancers. Risks for melanoma are significantly less than 1 in both sexes. The only significant difference in risk between blacks and mulattos is observed for colon cancer in males: relative to whites, risks are 1.42 (1.08-1.88) in mulattos and 0.47 (0.27-0.80) in blacks.

Discussion

In this study we have used a case-control approach to calculate odds ratios, adjusted for various confounding variables, as estimates of differences in risk by ethnic group. The reason for this was the nonvalidity of incidence rates, resulting from the lack of match between the definitions of ethnic group in numerator (registry) and denominator (census) data. According to the 1980 census (12), blacks and mulattos represented, respectively, 4.7 and 19.9% of the resident population of São Paulo, but only 3.2 and 4.8% of cancer registrations were so recorded. Using these data, the calculated incidence rates (age-standardized per 100,000) for all cancers were 222.9 and 198.5 in white males and females, 174 and 131.7 in blacks, and 78.5 and 85.1 in mulattos. These differences are obviously quite implausible. In the absence of appropriate population denominators, the most satisfactory analysis using numerator data alone was the case-control approach, where the controls comprise all noncases in the series (13). The odds ratio so estimated will equal the true relative risk if the mixture of conditions in the control group is not related to "exposure" (here, ethnicity), after accounting for stratification factors (7, 8). This assumption cannot be tested when rates are not

Table 4 Odds ratios (with 95% confidence interval)[a] by cancer site for mulatto and black males compared to white males, São Paulo cancer registry, 1969-1974

ICD-9 codes[b]	Site	No. of cases	% unknown ethnic group	Ethnic group		
				White	Mulatto	Black
141-5	Oral cavity[c]	1562	4.8	1.0	1.1 (0.9-1.4)	1.2 (0.9-1.5)
147	Nasopharynx	96	0.0	1.0	2.0 (0.9-4.1)	0.9 (0.3-3.0)
146, 8, 9	Other pharynx	785	3.3	1.0	0.8 (0.5-1.1)	1.2 (0.9-1.8)
150	Esophagus	1601	3.0	1.0	1.5 (1.2-1.8)[d]	2.6 (2.2-3.2)[d]
151	Stomach	5397	3.5	1.0	1.8 (1.6-2.1)[d]	1.6 (1.4-1.9)[d]
153	Colon	1084	6.5	1.0	1.4 (1.1-1.9)[e]	0.5 (0.3-0.8)[f]
154	Rectum	817	9.0	1.0	1.3 (0.9-1.8)	0.9 (0.6-1.4)
155	Liver	142	3.5	1.0	2.4 (1.4-4.4)[f]	1.0 (0.4-2.8)
156	Gall bladder	268	3.7	1.0	0.8 (0.4-1.7)	0.9 (0.4-1.9)
157	Pancreas	663	2.4	1.0	0.9 (0.6-1.3)	0.9 (0.6-1.5)
161	Larynx	1726	5.5	1.0	0.7 (0.6-1.0)[e]	1.0 (0.8-1.3)
162	Lung	3177	2.1	1.0	0.7 (0.5-0.8)[d]	0.7 (0.6-0.9)[f]
170	Bone	272	4.0	1.0	0.9 (0.5-1.5)	0.9 (0.5-1.8)
172	Melanoma	318	11.3	1.0	0.3 (0.1-0.8)[e]	0.4 (0.1-1.1)
185	Prostate	1845	5.8	1.0	1.4 (1.1-1.8)[f]	1.8 (1.4-2.3)[d]
186	Testis	228	10.0	1.0	0.3 (0.1-0.9)[e]	0.7 (0.3-1.6)
188	Bladder	1336	6.6	1.0	0.6 (0.4-0.9)[e]	0.5 (0.3-0.8)[f]
189	Kidney	306	4.9	1.0	0.9 (0.5-1.7)	0.6 (0.3-1.4)
191, 2	Nervous system	813	3.6	1.0	1.0 (0.8-1.4)	0.9 (0.6-1.3)
201	Hodgkin's disease	585	6.4	1.0	1.2 (0.8-1.7)	0.7 (0.4-1.2)
200, 2	Other lymphoma	912	7.4	1.0	1.2 (0.9-1.9)	1.0 (0.7-1.5)
203	Myeloma	110	3.6	1.0	0.9 (0.3-2.4)	2.8 (1.4-5.5)[f]
204	Leukemia	756	0.9	1.0	0.9 (0.7-1.3)	0.6 (0.4-1.0)[e]
	Ill defined[g]	2261	9.8	1.0	1.1 (0.9-1.4)	1.3 (1.0-1.6)[e]

[a] Odds ratios are adjusted for age (0-35, 35-44, 45-54, 55-64, 65+), civil status (ever married, other), period 1969-71, 1972-74), histological verification (yes, no), death ceritificate only case (yes, no), birthplace (Brazil-born, other), and social class (low, medium, high, other, unknown).
[b] International Classification of Diseases, 9th revision.
[c] Excluding salivary glands (ICD-9 code 142).
[d] $P < 0.001$.
[e] $P < 0.05$.
[f] $P < 0.01$.
[g] ICD-9 codes 159, 165, and 195-9.

Table 5 Odds ratios (with 95% confidence interval)[a] by cancer site for mulatto and black females compared to white females, São Paulo cancer registry, 1969–1974

ICD-9 codes[b]	Site	No. of cases	% unknown ethnic group	Ethnic group		
				White	Mulatto	Black
141–5	Oral cavity[c]	396	6.0	1.0	1.8 (1.2–2.6)[d]	1.6 (1.0–2.5)
146, 8, 9	Other pharynx	117	8.5	1.0	1.8 (0.9–3.5)	1.4 (0.6–3.5)
150	Esophagus	356	4.2	1.0	2.7 (1.9–3.7)[e]	3.0 (2.0–4.4)[e]
151	Stomach	2851	3.1	1.0	1.6 (1.4–1.9)[e]	1.5 (1.2–1.8)[e]
153	Colon	1273	6.9	1.0	0.7 (0.5–1.0)[f]	0.7 (0.5–1.0)
154	Rectum	915	7.2	1.0	0.8 (0.5–1.1)	1.1 (0.7–1.5)
155	Liver	61	3.2	1.0	2.3 (1.1–4.9)[f]	1.5 (0.5–4.7)
156	Gall bladder	546	4.2	1.0	1.6 (1.2–2.3)[d]	1.0 (0.6–1.6)
157	Pancreas	526	2.2	1.0	1.8 (1.3–2.4)[e]	1.0 (0.6–1.7)
161	Larynx	198	7.0	1.0	1.4 (0.8–2.5)	1.5 (0.8–2.9)
162	Lung	867	2.6	1.0	1.0 (0.8–1.4)	0.7 (0.5–1.1)
170	Bone	224	5.3	1.0	0.5 (0.2–0.9)[f]	0.5 (0.2–1.2)
172	Melanoma	334	11.0	1.0	0.5 (0.2–1.0)[f]	0.4 (0.2–1.1)
174	Breast	7735	7.3	1.0	0.6 (0.5–0.7)[e]	0.8 (0.7–0.9)[d]
179	Uterus NOS	556	5.3	1.0	1.5 (1.1–2.1)[d]	1.8 (1.3–2.6)[e]
180	Cervix uteri	5703	8.1	1.0	1.8 (1.6–2.0)[e]	1.5 (1.3–1.8)[e]
182	Corpus	1435	11.4	1.0	0.7 (0.5–0.9)[f]	1.2 (0.9–1.6)
183	Ovary	1209	6.9	1.0	0.9 (0.6–1.1)	1.2 (0.9–1.6)
188	Bladder	343	6.1	1.0	0.9 (0.5–1.6)	0.9 (0.5–1.6)
189	Kidney	284	6.6	1.0	0.9 (0.6–1.5)	0.7 (0.4–1.5)
191, 2	Nervous sytem	680	3.9	1.0	0.8 (0.5–1.0)	0.8 (0.5–1.2)
201	Hodgkin's disease	326	7.6	1.0	0.7 (0.4–1.2)	0.8 (0.4–1.6)
200, 2	Other lymphoma	626	5.5	1.0	1.1 (0.8–1.6)	1.2 (0.8–1.8)
203	Myeloma	103	6.7	1.0	1.2 (0.5–2.9)	1.7 (0.4–4.3)
204–8	Leukemia	696	0.7	1.0	1.0 (0.7–1.3)	0.7 (0.5–1.1)
	Ill defined[g]	2292	10.3	1.0	1.2 (1.0–1.5)[f]	1.4 (1.2–1.8)[e]

[a] Odds ratios are adjusted for age (0–35, 35–44, 45–54, 55–64, 65+), civil status (ever-married, other), period (1969–71, 1972–74), histological verification (yes, no), death certificate only case (yes, no), birthplace (Brazil-born, other), and social class (low, medium, high, other, unknown).
[b] International Classification of Diseases, 9th revision.
[c] Excluding salivary glands (ICD-9 code 142).
[d] $P < 0.01$.
[e] $P < 0.001$.
[f] $P < 0.05$.
[g] ICD-9 codes 159, 165, and 195–9.

available. In a previous study from North America, however, the overall cancer incidence rate was higher among blacks, but although the ratio of black to white age-adjusted rates varied widely between sites, for all sites combined it was only 1.11 for both sexes (4).

The quality of the São Paulo cancer registry records may be judged from the percentage of cases from a death certificate only (9%) and the level of histological confirmation (70%). Although the latter is quite low compared to registries in Europe and North America, it is similar to the percentage observed in other developing countries (14). The percentages vary with ethnic group, the quality of records being lower among blacks and mulattos, while the proportion of cases with histological verification is very high among the unknown ethnic group, since these include many cases identified from pathology records alone, where ethnicity is not recorded. Despite these differences, the proportion of cases registered with ill-defined primary site of cancer varies little with ethnicity, and it is very unlikely that they can account for more than a small proportion of the estimated variation in risk. All of the relative risk estimates in this study are, in any case, adjusted for these quality indicators.

In Brazil, whites are descended from Portuguese, Italian, Spanish, and German immigrants. Mulattos are from mixed marriages between the black and white populations. Blacks, as in North America, are descended from African slaves transported during the sixteenth century in order to work in cotton fields and, later, on coffee plantations. The Asians living in Brazil (recorded as "yellow" in the cancer registry and census) are mostly Japanese who came to substitute for the slave work force in the coffee farms in the beginning of this century. Definition of ethnic group as recorded in the São Paulo registry almost certainly gives rise to some misclassification bias, since the differences between mulattos and blacks as well as those between mulattos and whites can be rather small.

In North America, the greater general morbidity of blacks compared to whites throughout their life is believed to result mainly from economic and social inequalities. Blacks in North America have more limited access to health services, which contributes to underdiagnosis and delayed or inadequate treatment of chronic health problems. In São Paulo, the proportion of cancer cases from the lower social classes is higher in the black and mulatto than the white population, and cancer mortality is also related to social class.[2] All of the relative risk estimates are adjusted for social class, but because of the high proportion of cases with unknown social class, the possibility of residual confounding, particularly for females, must be borne in mind.

[2] C. Bouchardy, D. M. Parkin, M. Khlat, A. P. Mirra, M. Kogevinas, F. D. de Lima, and C. E. de Cravalho Ferreira. Education and mortality from cancer in São Paulo, Brazil, submitted for publication.

Blacks in North America as well as in Brazil originated mainly from West Africa, and for those black populations descended from African slaves, the only studies comparing cancer risks with whites living in the same place come from the United States. Other available data relate to migrants from East and West Africa in England and Wales (15). In spite of the possible differences in the geographic origins and presumably genetic composition of these groups, the results among blacks born in São Paulo will be compared to those available in blacks born in the United States and in populations in West Africa.

Esophageal Cancer. Compared to whites, blacks and mulattos of both sexes have high risks of esophageal cancer, with a 3-fold increase in black females. In the United States, one of the strongest relationships with race is also for this cancer, with incidence rates in blacks more than 3 times higher than those in whites (4). Alcohol consumption, tobacco smoking, and poor nutrition are risk factors for this cancer. In São Paulo, tobacco smoking is unlikely to account for the racial differences, since risk estimates for other cancers related to tobacco, such as lung, larynx, and bladder, are below unity among nonwhites. Since there is also an increased risk of oral cancer in São Paulo blacks and mulattos, particularly in females, differences in alcohol intake between ethnic groups could be important. *Cachaça*, a distilled sugarcane spirit, is one of the most common alcoholic beverages in Brazil. The consumption of *cachaça* has been found to be strongly related to both esophageal and oral cancer in southern Brazil (16, 17). *Maté*, an infusion made from *Ilex paraguayenis*, which is traditionally drunk at a very high temperature in Brazil, Uruguay, and Argentina, has been shown to be a risk factor for esophageal cancer (18). In the absence of population consumption data, it is impossible to know whether differences between ethnic groups in the drinking of *maté* or *cachaça* can explain the differences in esophageal cancer risk. Fruit consumption has been found to be protective for esophageal cancer in Brazil (16), and this or other nutritional differences between black and white populations may also account for differences in the risk of esophageal cancer (19).

Stomach Cancer. The incidence of stomach cancer is high in several parts of South America, and in São Paulo it is the most common cancer in males and the third most common in females. Blacks and mulattos have higher risks in both sexes. In the United States, where stomach cancer is rather uncommon, blacks also have about twice the incidence of whites (20). Recent data from West Africa suggest that stomach cancer is the second most frequent cancer in males after liver cancer (21, 22). Since there are marked variations of stomach cancer occurrence according to socioeconomic status (23), the ethnic difference observed in the United States has been largely attributed to the lower socioeconomic status of the blacks. Although risks in this study are adjusted for this variable, a relatively large percentage of cases were of unknown social class. However, when relative risk was examined within social class categories, the ethnic differential was similar in all classes, even in the low social class in males. Ethnic variation in nutritional habits, particularly in fruit consumption, may, as for esophageal cancer, be involved.

Colon Cancer. The incidence of colon cancer is low in Brazil, although the rates are rather higher in southern states where the extent of urbanization and westernization of life styles is most pronounced (14). Blacks have a lower colon cancer risk than whites in both sexes in São Paulo, a differential that is no longer observed in the United States, where since about 1980 incidence rates of colon cancer are actually higher among blacks (20); for females the highest rates in the world are recorded among blacks in Detroit (14).

In São Paulo, the traditional inverse relationship between the risks for stomach and colon cancers still holds for blacks but not for male mulattos, who, surprisingly, have a higher risk of colon cancer than white males. Further analyses stratified on age (not shown) indicate that the increase in colon cancer risk in mulattos relative to whites is observed only in the younger age groups (<45 years). It could be that this increase represents a change in risk in recent birth cohorts of males, possibly due to changing nutritional habits. Given the large number of statistical tests performed in this study, however, it could be simply the result of chance.

Liver Cancer. Liver cancer is the most common cancer among males in West Africa (24), while populations of Western European origin have relatively low risks (25). In São Paulo, liver cancer rates are low in both sexes but, compared to whites, mulattos have a greater than 2-fold increased risk. This is not observed in blacks, among whom the number of cases was very small (4 and 3 cases in males and females, respectively). Blacks living in the United States have rates that are nearly 2-fold higher than those for whites (20), and immigrants to Britain from the British Commonwealth nations of Africa also have a higher proportional mortality ratio for liver cancer than the local-born (15). Factors such as alcohol intake or hepatitis B virus infection may be involved in these ethnic differences (26).

Other Digestive Cancers. Some of the highest incidence rates in the world for pancreatic cancer have been recorded in the black population of the United States, with a ratio of age-adjusted rates in blacks *versus* whites of about 1.4 (4). In São Paulo, blacks have a risk for pancreatic cancer similar to that of whites, but mulatto women have a significantly increased risk over whites, as they do for gallbladder cancer. Possible risk factors for these cancers, which are known to be more common in black females in the United States, are obesity and diabetes (27, 28), but no data by ethnicity are available from South America.

Respiratory Cancers. In São Paulo, in males, the risk of lung cancer in both blacks and mulattos and of larynx cancer in mulattos is significantly lower than in whites. In the United States, in the past, incidence rates of lung cancer were higher among whites compared to nonwhites, but since about 1960 the reverse has been observed (29). The higher rates in American black males relate in most part to differences in socioeconomic status (3), although the precise factors responsible are less clear. In São Paulo, the ethnic differential in risk is rather similar within the social class categories. There are no data on smoking habits by ethnic group in Brazil, and it is possible that widespread cigarette smoking, a more recent phenomenon here than in North America, was established earlier in the white than in the nonwhite population.

Melanoma of the Skin. The most striking example of genetic differences between black and white populations

is malignant melanoma of the skin. The low risk of malignant melanoma of the skin in the black and mulatto populations in São Paulo (the former is nonsignificant because of small numbers) is in keeping with the very low incidence of this cancer in other black populations (30).

Breast Cancer. The lower risk of blacks and mulattos compared to whites in São Paulo is similar to the ethnic variation in risk observed in the United States (4). A strong relationship to social class has been repeatedly reported, with increased risks in higher socioeconomic strata. In the United States only about one-half of the black-white difference can be explained by socioeconomic factors (2). In São Paulo, adjustment of the odds ratios for social class makes almost no difference to the ethnic difference, but, since some 70% of women are in the "Other" category, this is unsatisfactory. The numbers of cases within each social class category are too small to draw firm conclusions about ethnic differences within social class groups. Reproductive factors, such as early age at menarche, late age at first pregnancy, low parity, and late age at menopause, which are associated with high breast cancer risk (31), may be more prevalent among whites than among other ethnic groups. Genetic differences in breast cancer susceptibility between whites and mullatos as well as between the white and the black populations are also probably involved.

Gynecological Cancer. Nearly all data on cervical cancer have indicated striking ethnic differences in the age-adjusted incidence rates. In the United States, invasive cervical cancer was diagnosed twice as frequently among black females as among white females (4). Since cervical cancer is known to be inversely related to social class, black-white differences could be attributed partly to the lower social status of black women, and indeed socioeconomic adjustment reduces by two-thirds the excess risk of cervical cancer among black women in North America (2). In São Paulo, the quality of the records on social class among women is too poor to exclude an important residual effect of social class, although higher risks in mulatto and black females are present in all social class strata. In South America, as in other countries, a young age at first coitus and multiple partners appear to be the factors most strongly associated with cervical cancer risk (32), although high parity also confers an increased risk (33). The extent to which these factors may explain ethnic differences in São Paulo is unknown. Cervical Pap smear screening tests can greatly reduce the risk of invasive disease (34). In São Paulo, mass detection of cervical cancer was initiated around 1970 (35), although no data are available on participation rates according to ethnicity.

Prostatic Cancer. Cancer of the prostate is common in black populations, particularly in North America and in the Caribbean, but the frequency recorded in case series from Africa is also relatively high (36). Black Americans have the highest incidence rate of prostate cancer in the world, with incidence rates 50% higher than those in whites in some areas (14). The pattern in São Paulo is similar, with a trend of increasing risk from white to mulatto to black. It has been hypothesized that the higher testosterone level found in American black males may predispose them to the development of prostatic cancer (37); other factors such as difference in diet, as well as in sexual habits or venereal infections, may also be important (38).

Testis Cancer. The low risk of testis cancer in mulattos compared to whites (the difference for blacks was nonsignificant) is similar to the ethnic variation reported from the United States (5). Low rates in black populations could be related to differences in hormonal environmental exposure *in utero* or in early life, since higher circulating levels of testosterone have been found in pregnant black women compared to pregnant white women (39).

Bladder Cancer. In the United States, the risk for bladder cancer in white males is approximately twice that in black males (5), and the same ratio is observed in São Paulo, where black and mulatto males have, respectively, one-half and two-thirds the risk of white males. Smoking habits and occupation are the main risk factors in areas where schistosomiasis is not endemic, but smoking cannot explain the differences observed in the United States for both lung (increased in blacks) and bladder cancers (decreased in blacks). In Brazil, however, these three tobacco-related cancers show similar ethnic variation.

Myeloma. In the United States, multiple myeloma is the most common form of malignancy of the lymphohematopoietic system in blacks (33% compared to 14% in whites) (20), although it appears to be rare in Africa, probably due to limited diagnostic facilities. In addition to the markedly increased incidence, multiple myeloma is one of the very few cancers with a more favorable survival rate in American blacks than whites (4). Blacks in São Paulo also have an elevated risk compared to whites; this was not apparent among mulattos. There may be a genetic difference in the biology or natural history between whites, mulattos, and blacks, although environmental exposures such as previous infection and occupational exposures (carbon monoxide) may also play a role (40).

Leukemia. The incidence of lymphatic leukemia is generally lower in blacks than in whites (14). In São Paulo, risks among black males are also significantly lower than risks among white males; this was not observed among mulattos. Among U.S. blacks, however, the leukemia deficit was particularly prominent in older age groups (5), and in São Paulo the lowest risk is also observed in the age group over 65 years (data not shown), suggesting that, to some extent, it represents deficient case detection due to medical care availability.

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