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Background. This study examines cancer mortality among Chinese migrants in New York City, and compares it with that of residents of China as well as New York City whites.

Method. Mortality records for 1988–1992 from the New York City Department of Health, and the 1990 US census data for New York City were used for the analysis. Age-specific deaths and the population of urban China reported by the World Health Organization were also used for comparison. Age-adjusted death rates by gender for Chinese and whites in New York City, as well as for Chinese in China were computed using the world standard population.

Results. New York Chinese had lower mortality rates for all causes, total cancer, oesophageal and lung cancer deaths than did either New York whites or Chinese in China in both genders. However, they had lower death rates than New York whites, but similar to those in China, for colon cancer in both genders, and breast cancer in females. By contrast, New York Chinese had higher death rates for nasopharyngeal cancer than either New York City whites or Chinese in China. Stomach and liver cancer death rates in New York Chinese fell between those in China and New York City whites.

Conclusions. Cancer mortality rates among Chinese migrants in New York City being the lowest for total cancer and some types of cancers, did not follow the usual pattern of migrants (an intermediate position between rates of native New Yorkers and Chinese in homeland China). However, substantial variations in certain cancer-specific mortality by geography were observed.

Keywords: cancer mortality, migration, Chinese, New York City

The health status of migrants usually differs from that of non-migrants. These differences provide an opportunity to separate the influences of genetic and environmental factors on human health. The incidence and patterns of cancer occurrence in migrants may also offer an opportunity to identify potentially modifiable environmental or behavioural characteristics that can lead to preventive strategies.

Usually, cancer mortality rates in migrants are intermediate between rates in their home country and those of natives in their adopted country. For example, Stellman has noted that the proportional mortality ratios for certain cancers in the Chinese migrants in New York City fell between those of New York whites and residents of Tianjin, China. However, because of the absence of population-based data, these comparisons were based on proportional cancer mortality ratios, rather than the more precise mortality rates.

We now report, based on recent census data (1990) and 5-year mortality records from 1988 to 1992 for New York City, the mortality rates for certain cancers among Chinese in New York City and compare these rates with New York City whites and Chinese in China.

DATA AND METHODS

Data Source

This analysis was based upon New York City census data obtained from the 1990 US census public use microdata sample, and mortality records for the 5-year period 1988–1992 obtained from the New York City Department of Health.

Census data. Census data for New York City were obtained from the Department of Data Service, City University of New York. The data set used was the 1990 census public use microdata sample. This is the largest available census data set and contains a roughly 1 in 20 sample. A weighted variable was included to define the total population.

The variables included in the census data set were: borough of residence, race, age in years, gender, place of birth, education, and marital status. The race was recorded on white, black, American Indian, Asian (Chinese, Japanese, etc.) or Pacific Islander and
other race. The definition of race represents self-classification according to the race with which he or she most closely identified. During direct interviews conducted by enumerators, if a person could not provide a single response to the race question, he or she was asked to select the group which best described his or her racial identity. If a person still could not provide a single race response, the race of the mother was used. If a single race response could not be provided for the person's mother, the first race reported by the person was used. In all cases where occupied housing units, households, or families were classified by race, the race of the householder was used. The racial definition for Chinese in the 1990 census data includes people who indicated their race as 'Chinese' or who identified themselves as Cantonese, Tibetan, or Chinese American. For whites, it included those who indicated their race as 'white' or reported entries as Canadian, German, Italian, Lebanese, Near Easterner, Arab or Polish.

Mortality data. Death certificate information for five years from 1988 to 1992 was provided by the New York City Department of Health on computer tape, which had reports on all vital events in New York City during this period. Personal identifying information from all death certificates was eliminated to preserve confidentiality. The death certificate contained information on race, ancestry, birthplace, and other demographic information. Underlying causes of death were coded according to the Ninth Revision of International Classification of Diseases (ICD-9). The selected cancers included in this analysis were defined the same way as the World Health Organization (WHO) statistics annual report and they were all malignant neoplasms (ICD-9 140-208, 230-234); malignant neoplasms of: nasopharynx (ICD-9 147, 230); oesophagus (ICD-9 150, 230.1); stomach (ICD-9 151, 230.2); colon and rectum (ICD-9 153-154, 230.3-230.6); liver (ICD-9 155, 230.8); lung (ICD-9 162, 231.1-231.2); female breast (ICD-9 174, 233.0); and cervix uteri (ICD-9 180, 233.1).

Data Analysis
Mortality rates for all causes, as well as each selected cause of cancer were calculated by dividing the number of cancer deaths in 1988–1992 by the population (from census data) in 1990 for New York City whites and Chinese. For Chinese in urban China, the age-specific cancer deaths and population numbers for 1990 reported by WHO were computed to calculate mortality rates.

Gender-specific age-adjusted death rates of Chinese and whites in New York City were computed by direct standardization using World Standard Population reported by WHO in 1990. For New York Chinese and whites, death rates are based upon the aggregation of 5-year figures (1988–1992), and annual death rates were computed dividing the 5-year rates by five. For Chinese in China, it was based on data for 1990 reported by WHO. Comparisons of age-adjusted rates between the three population groups were made by relative risks (RR) and 95% confidence intervals (CI).

RESULTS
Overall, Chinese (245 565) comprised about 3.4% of the total New York City population (7 289 839). Compared with New York whites (Table 1), New York Chinese were 7 years younger and slightly more likely to be male. They also had much lower educational attainment (64% versus 83% for high school and above) and slightly higher unemployment status (15.1% versus 12.9%) than did New York City whites. Similar data for Chinese in China were not available for comparison.

Cancer Mortality Among Three Groups
In all three groups, neoplasms were the second leading cause of death, accounting for 29.9%, 23.0% and 22.1% of total deaths for New York Chinese, New York whites and Chinese in China respectively.

Age-adjusted cancer mortality rates for Chinese in China, New York Chinese and New York whites are displayed in Table 2 for males and Table 3 for females. Compared with Chinese in China and New York City whites, New York City Chinese had the lowest death rates for all causes, all cancers, as well as for oesophagus and lung cancers for both males and
### Table 2: Age-adjusted annual death rates (1/100,000) of Chinese and whites in New York City (NYC), 1988–1992, and urban Chinese in China, 1990 for males

<table>
<thead>
<tr>
<th>Condition</th>
<th>Chinese</th>
<th>Whites</th>
<th>RR (95% CI)</th>
<th>RR (95% CI)</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>China</td>
<td>NYC</td>
<td>NY Chinese/China</td>
<td>NY Chinese/Whites</td>
<td>China/Whites</td>
</tr>
<tr>
<td>All causes</td>
<td>591.5(181 478)b</td>
<td>282.5(2510)</td>
<td>0.48 (0.45–0.51)</td>
<td>0.46 (0.43–0.49)</td>
<td>0.97 (0.92–1.02)</td>
</tr>
<tr>
<td>All cancers</td>
<td>133.3(45 336)</td>
<td>79.8(745)</td>
<td>0.60 (0.53–0.68)</td>
<td>0.62 (0.55–0.70)</td>
<td>1.03 (0.93–1.02)</td>
</tr>
<tr>
<td>(ICD-9 140–208, 230–234)</td>
<td>2.4(550)</td>
<td>3.9(44)</td>
<td>1.79 (1.03–4.47)</td>
<td>11.78 (2.47–30.02)</td>
<td>6.06 (1.86–25.03)</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>11.6(3867)</td>
<td>1.7(16)</td>
<td>0.13 (0.16–0.18)</td>
<td>0.52 (0.21–0.97)</td>
<td>3.75 (2.16–6.51)</td>
</tr>
<tr>
<td>(ICD-9 147, 230.0)</td>
<td>2.4(852)</td>
<td>3.9(44)</td>
<td>0.13 (0.16–0.18)</td>
<td>0.52 (0.21–0.97)</td>
<td>3.75 (2.16–6.51)</td>
</tr>
<tr>
<td>Oesophagus</td>
<td>2.4(852)</td>
<td>3.9(44)</td>
<td>0.13 (0.16–0.18)</td>
<td>0.52 (0.21–0.97)</td>
<td>3.75 (2.16–6.51)</td>
</tr>
<tr>
<td>Stomach</td>
<td>24.2(1815)</td>
<td>7.1(68)</td>
<td>0.29 (0.20–0.42)</td>
<td>1.40 (1.08–2.04)</td>
<td>4.80 (3.12–7.38)</td>
</tr>
<tr>
<td>Colon, Rectum</td>
<td>7.3(2465)</td>
<td>7.3(71)</td>
<td>1.06 (0.67–1.68)</td>
<td>0.50 (0.30–0.79)</td>
<td>0.49 (0.33–0.73)</td>
</tr>
<tr>
<td>(ICD-9 153–154, 230.3–230.6)</td>
<td>23.6(1697)</td>
<td>12.9(114)</td>
<td>0.52 (0.38–0.70)</td>
<td>3.44 (2.04–5.82)</td>
<td>6.67 (4.06–10.94)</td>
</tr>
<tr>
<td>Liver</td>
<td>23.6(1697)</td>
<td>12.9(114)</td>
<td>0.52 (0.38–0.70)</td>
<td>3.44 (2.04–5.82)</td>
<td>6.67 (4.06–10.94)</td>
</tr>
<tr>
<td>Lung</td>
<td>36.6(12 560)</td>
<td>24.2(233)</td>
<td>0.65 (0.52–0.82)</td>
<td>0.66 (0.53–0.83)</td>
<td>1.01 (0.82–1.24)</td>
</tr>
</tbody>
</table>


b Numbers of deaths.

### Table 3: Age-adjusted annual death rates (1/100,000) of Chinese and whites in New York City (NYC), 1988–1992, and urban Chinese in China, 1990 for females

<table>
<thead>
<tr>
<th>Condition</th>
<th>Chinese</th>
<th>Whites</th>
<th>RR (95% CI)</th>
<th>RR (95% CI)</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>China</td>
<td>NYC</td>
<td>NY Chinese/China</td>
<td>NY Chinese/Whites</td>
<td>China/Whites</td>
</tr>
<tr>
<td>All causes</td>
<td>559.7(151 120)b</td>
<td>233.7(1697)</td>
<td>0.42 (0.39–0.55)</td>
<td>0.53 (0.49–0.56)</td>
<td>1.30 (1.26–1.33)</td>
</tr>
<tr>
<td>All cancers</td>
<td>90.7(27 458)</td>
<td>63.4(495)</td>
<td>0.70 (0.60–0.80)</td>
<td>0.54 (0.47–0.62)</td>
<td>0.77 (0.68–0.87)</td>
</tr>
<tr>
<td>(ICD-9 140–208, 230–234)</td>
<td>1.1(353)</td>
<td>0.9(15)</td>
<td>0.80 (0.14–2.51)</td>
<td>4.46 (1.08–8.84)</td>
<td>5.55 (2.34–10.67)</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>5.6(1648)</td>
<td>1.1(6)</td>
<td>0.20 (0.08–0.36)</td>
<td>0.64 (0.32–0.97)</td>
<td>3.29 (2.84–3.78)</td>
</tr>
<tr>
<td>(ICD-9 147, 230.0)</td>
<td>13.5(4045)</td>
<td>4.1(33)</td>
<td>0.32 (0.20–0.53)</td>
<td>1.50 (1.06–2.05)</td>
<td>4.64 (2.61–8.27)</td>
</tr>
<tr>
<td>Oesophagus</td>
<td>13.5(4045)</td>
<td>4.1(33)</td>
<td>0.32 (0.20–0.53)</td>
<td>1.50 (1.06–2.05)</td>
<td>4.64 (2.61–8.27)</td>
</tr>
<tr>
<td>Stomach</td>
<td>7.4(2233)</td>
<td>8.1(63)</td>
<td>1.14 (0.73–1.80)</td>
<td>0.5063 (0.43–0.94)</td>
<td>0.56 (0.37–0.84)</td>
</tr>
<tr>
<td>Colon, Rectum</td>
<td>7.4(2233)</td>
<td>8.1(63)</td>
<td>1.14 (0.73–1.80)</td>
<td>0.5063 (0.43–0.94)</td>
<td>0.56 (0.37–0.84)</td>
</tr>
<tr>
<td>(ICD-9 153–154, 230.3–230.6)</td>
<td>9.8(3029)</td>
<td>5.2(38)</td>
<td>0.52 (0.32–0.84)</td>
<td>2.36 (1.17–4.78)</td>
<td>4.55 (2.37–8.73)</td>
</tr>
<tr>
<td>Liver</td>
<td>20.1(6141)</td>
<td>14.5(115)</td>
<td>0.72 (0.53–0.93)</td>
<td>0.63 (0.47–0.85)</td>
<td>0.88 (0.67–1.15)</td>
</tr>
<tr>
<td>Lung</td>
<td>5.8(1851)</td>
<td>6.6(54)</td>
<td>1.15 (0.64–2.21)</td>
<td>0.26 (0.18–0.38)</td>
<td>0.23 (0.16–0.35)</td>
</tr>
<tr>
<td>(ICD-9 174, 233.0)</td>
<td>2.8(840)</td>
<td>1.2(19)</td>
<td>0.40 (0.06–1.03)</td>
<td>0.75 (0.26–2.12)</td>
<td>1.88 (0.79–4.42)</td>
</tr>
<tr>
<td>Cervix</td>
<td>2.8(840)</td>
<td>1.2(19)</td>
<td>0.40 (0.06–1.03)</td>
<td>0.75 (0.26–2.12)</td>
<td>1.88 (0.79–4.42)</td>
</tr>
<tr>
<td>(ICD-9 180, 233.1)</td>
<td>2.8(840)</td>
<td>1.2(19)</td>
<td>0.40 (0.06–1.03)</td>
<td>0.75 (0.26–2.12)</td>
<td>1.88 (0.79–4.42)</td>
</tr>
</tbody>
</table>


b Numbers of deaths.
females. Colon and rectum cancers in both genders, and breast cancer in females among New York Chinese were not significantly different from those in China, and both were significantly lower than New York City whites. The deaths caused by stomach and liver cancers among New York Chinese were intermediate between those in China (highest) and New York City whites (lowest) for both genders. New York Chinese of both genders had sharply higher death rates for nasopharyngeal cancer (RR = 11.8 for males, and 4.46 for females) than did New York City whites. However, in comparison with those in China, the high death rate of nasopharyngeal cancer among New York City Chinese was observed only in males. In females, there was no significant difference between the two groups. No significant difference for cervical cancer death was observed among the different groups.

DISCUSSION

The principal finding of this mortality analysis is that both all cause and total cancer mortality rates were lower for Chinese living in New York City than either New York City whites or Chinese in China. This is in contrast to the general observation that mortality rates in migrants are intermediate between those in their homeland and those of natives in the adopted country. Further analysis of the individual cancer mortality rates revealed substantial variation by race and geography. In particular, stomach and liver cancer death rates of New York City Chinese were intermediate between those in China and New York City whites. By contrast, however, colon and breast cancer deaths were similar among New York Chinese and those in China, but less frequent than New York whites. Nasopharyngeal cancer in New York Chinese males was substantially more common than in either New York whites or Chinese in China. On the other hand, New York Chinese had the lowest death rates for oesophageal cancer and lung cancer.

These differences in mortality rates of certain cancers between natives and migrants point to the varying influences of environment and genetics on the development of disease. Risk changes as environment is altered. In comparing migrant mortality rates to non-migrants and natives of the migrants’ destination, if the environment is important, one would expect that non-migrants would differ from migrants, and that migrant rates would tend toward those of the country of adoption. On the other hand, if genetic factors predominate, the death rates of non-migrants and migrants would tend to be similar; both would differ from the natives of the country of adoption.

Dietary intake is perhaps the environmental factor most likely to change with migration and thus influence health status. It has been found that a high intake of fat and total calories and low intake of fibre are associated with the occurrence of colorectal and breast cancers. Americans derive an average of 43% of total calories from fat, compared to less than 20% of total calories in the Chinese diet. In addition, the consumption of cereals and vegetables, the primary sources of fibre, is higher in China than the US. These patterns are therefore consistent with the variation in mortality for colorectal cancer. Not surprisingly, the risk increased with duration of migrant residence in America. For breast cancer, it has been shown that the risk in Chinese-Americans is transitional between Chinese in China (low risk) and Americans (high risk). An increased consumption of dietary fat may account for this finding. Instead of being intermediate for breast and colon cancer, our analysis showed that Chinese in New York had lower death rates for colon and breast cancer than New York whites but similar death rates to those in China. Perhaps genetic factors were more important than environmental factors in the aetiology of these cancers.

Stomach and liver cancer deaths in New York Chinese were significantly more common than among New York whites, but lower than Chinese in China. It is well known that primary liver cancer has been a major health problem in China for many years. This probably reflects the high prevalence of hepatitis B virus infection in China. It has also been found that the first generation of Chinese migrants had a higher risk of liver cancer than did the second generation. Stomach cancer, the leading cause of malignant death in China, has been observed to be related to the traditional Chinese way of preserving food, which was frequently contaminated by Helicobacter pylori. A reduction in risk for stomach cancer in second generation migrants has been noted for Japanese, which suggests either that one or more risk factors carried from the home country could have been eliminated, perhaps by the new protective factors.

There have been reports that cervical cancer is common in China. Our findings suggest no significant difference in cervical cancer between New York Chinese, New York whites and Chinese in China. Confidence in this finding is limited, however, because of the small number of cases observed.

The lower lung cancer death rate among New York Chinese males and females compared with New York whites and Chinese in China probably reflects effects of the aetiological factor of cigarette smoking and other environmental factors. This might relate to less
cigarette smoking among Chinese migrants. Higher rates of lung cancer among females in China have been reported. Smoking is not as common in females in China as it is in Chinese males or in Western females. It has been noted that the exposure to indoor burning of smokey coal in certain parts of China may be associated with lung cancer rather than tobacco smoking. On the other hand, a higher death rate from lung cancer among white females is related to smoking.

Oesophageal cancer death probably relates to smoking and alcohol consumption in the US. In China, however, poor nutrition and/or ingestion of pickled and preserved foods contaminated with Aspergillus flavum may be the principal factor. Thus, the lower oesophageal cancer death rate found in Chinese migrants might reflect reduced exposure to both of these sets of risk factors.

Perhaps the most striking finding in this study was the high death rate for nasopharyngeal cancer in New York City Chinese males. The Cantonese populations of southeastern China have the highest rates for this cancer in the world, whereas elsewhere it is a very rare tumour. New York Chinese have, until recently, come mostly from Guangdong and other places in South China. Epidemiological studies suggest a multifactorial aetiology for nasopharyngeal cancer involving infection with Epstein Barr virus (EBV), genetic predisposition, environmental factors, such as consumption of salted fish, and other unknown factors.

It has previously been reported that Chinese Americans had lower death rates for this cancer, compared with Chinese in Guangdong and Hong Kong. Moreover, second generation Chinese-Americans have a lower risk than did the first, which was still higher than American whites. Thus, while the environment contains important aetiological and perhaps triggering factors, genetic influences also play a role in the development of disease. Of note is the large difference between male and female migrants. While Chinese migrant males have higher mortality than either Chinese in China or New York whites, females had mortality similar to those in China, but higher than New York City whites. The explanation for this gender variance is not readily available. Perhaps migrant females were more likely to come from parts of China, other than Guangdong, where the incidence of this cancer is lower. It seems unlikely that aetiological factors would differ in males and females.

Cancer incidence and mortality rates in this migrant population, as in other settings, are often intermediate between rates in their home country and for natives in their adopted country. However, we found that migrant cancer mortality rates were not invariably intermediate between place of origin and destination.

This might relate to special characteristics of the migrant population, who partly share the genetic pattern of China, but are also a selected group that might differ sharply from the Chinese average in many important aspects. In addition, the access to health care in the three groups might not be the same. Migrants are less likely to have health insurance than whites, which may tend to increase the mortality rates, despite similar incidence rates. On the other hand, the process of migration requires financial resources and a certain level of health, which might be associated with lower mortality rates among New York Chinese. The role of genetic and environmental influences among Chinese migrants in New York City can only be determined through further epidemiological investigation.

The limitations of this ecological study relate to the imperfection of both 1990 US census and death records. There might have been some underestimation of aliens, minorities and illegal immigrants in the census. However, undercounting is believed to be very low because several coverage improvement programmes were implemented during the census. On the other hand, mortality data are likely to be more complete. As a result, death rates in a migrant group might be inflated. However, there is no reason to believe that important systematic bias attends this process. Further, the aggregation of 5-year deaths, and the concentration on broad categories of mortality, tend to increase our confidence in the overall directions presented here.

In summary, we have found that the overall cancer mortality experience of migrant Chinese was not intermediate between residents of the home country and natives of their adopted country. There was substantial variation in cancer-specific mortality rates by geography. These findings suggest that environmental and/or genetic factors may have different impacts on specific cancers, which may provide clues to pursue in investigating the important specific factors for particular cancers.

REFERENCES


(Revised version received February 1996)