

## INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

**The quality of this reproduction is dependent upon the quality of the copy submitted.** Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

ProQuest Information and Learning  
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA  
800-521-0600

**UMI<sup>®</sup>**





Université d'Ottawa • University of Ottawa



# **Cancer Incidence and Survival Patterns among Chinese Immigrants in the United States**

by

**FAN SHI**

Faculty of Medicine,  
Department of Epidemiology and Community Medicine

To be submitted in partial fulfilment  
of the requirements for the degree of  
Master of Science

School of Graduate Studies and Research  
The University of Ottawa  
Ottawa, Ontario

April, 2000



National Library  
of Canada

Acquisitions and  
Bibliographic Services

395 Wellington Street  
Ottawa ON K1A 0N4  
Canada

Bibliothèque nationale  
du Canada

Acquisitions et  
services bibliographiques

395, rue Wellington  
Ottawa ON K1A 0N4  
Canada

*Your file* *Votre référence*

*Our file* *Notre référence*

The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

0-612-58504-2

**Canada**

## **ABSTRACT**

### **Objective:**

To examine the incidence and survival rates of selected cancer sites among second generation Chinese immigrants and to compare these rates to those of first generation Chinese immigrants as well as to the US born white Americans in the United States. The secondary objective of this study is to compare three different methods for calculating survival rate.

### **Methods:**

The combination of ethnicity and birthplace was used to identify first and second generation Chinese immigrants and US born white Americans. Cancer incident cases for three comparison groups were obtained from the population-based Surveillance, Epidemiology, and End Results (SEER) Program in the United States. Population counts for each study group were extracted from The Integrated Public Use Microdata Series (IPUMS-98), which consists of samples of the American population drawn from the federal censuses by the Census Bureau. Direct Age-standardized incidence rates (ASIRs) were calculated using the “world population” as a standard. ASIRs were compared among first, second generation Chinese immigrants and US born white Americans for nasopharyngeal, esophageal, stomach, liver, colon, rectum, lung, female breast and prostate cancers.

Observed, relative and cause-specific survival rates were calculated for the three study groups. The advantages and disadvantages of the three survival rates were compared. Cause-specific survival rates for female breast, prostate, colorectal, and lung cancer were compared among first and second generation Chinese immigrants and US born white Americans. Multivariate survival analysis was conducted using Cox proportional hazard model. In order to compare the cause-specific survival rates of second and first generation Chinese immigrants and US born white Americans, other prognostic factors, such as stage at diagnosis, age, gender, and had or did not have directed surgery during first therapy, SEER registry, and marital status, were examined.

### **Results:**

In general, second generation Chinese immigrants had incidence rates intermediate between first generation Chinese immigrants and US born white Americans. Second generation Chinese immigrants had a lower chance than first generation and had a higher chance than US born white Americans to get cancer of nasopharyngeal, stomach, and liver cancers. On the other hand, second generation Chinese immigrants had a higher risk than first generation and had a lower risk than US born white Americans to develop cancer of prostate and female breast cancers. However, they retained high rates of nasopharynx and liver cancers in both males and females. These results are consistent with most other similar studies.

The cause-specific survival rates of second generation Chinese immigrants showed higher survival than US born white Americans in most selected cancer sites. After adjusting for other prognostic factors, the effect still exists in prostate and lung cancers. Stage at diagnosis was the strongest prognostic factor for estimating survival of cancer patients.

**Conclusion:**

There are differences in cancer incidence among first and second generation Chinese immigrants and US born white Americans in the United States. These differences provide some evidence toward separating the influences of genetic and environmental factors on developing specific cancers. An ethnic disparity in cancer survival exists between Chinese and US born whites in the United States. Other possible explanation for the difference in survival, such as socioeconomic status, treatment choices, diet, genetics and health status, need to be explored in future studies.

## ACKNOWLEDGMENTS

I would like to express my sincere thanks to Dr. Nicholas Birkett, my supervisor, for his consultation and guidance through my thesis work. Thanks should also be given to Dr. Yue Chen and Dr. Eva Grunfeld, the members of my thesis committee, for their consultation and agreeing to read this thesis. Without their constant support, encouragement and patience, it would have been impossible for me to finish this work.

I'm grateful to Dr. Rama Nair for his advice in building the mathematic model to interpolate population counts for inter-censal years. Many thanks also to my examining committee for the helpful comments and thoughtful criticisms provided. They are Dr. Robert Spasoff and Dr. Rama Nair.

The Department of Epidemiology and Community Medicine at the University of Ottawa, whose faculty and students have contributed to my learning experience over the past two and half years. Thanks to Ms. Fay Draper, Ms. Mariella Peca and Carole Lachaine for their invaluable assistance. In addition, I would like to thank the University of Ottawa for the financial support of this work. And many thanks to my colleagues, particularly Dr. Wei Lou who provided invaluable information in many aspects.

Finally and most importantly, many thanks to my husband and my parents for their inspiration, confidence and patience.

# TABLE OF CONTENT

TITLE PAGE .....	i
ABSTRACT.....	ii
ACKNOWLEDGMENTS.....	v
TABLE OF CONTENT .....	vi
LIST OF TABLES.....	xi
LIST OF FIGURES.....	xiv
CHAPTER 1. INTRODUCTION .....	1
1.1 General: .....	1
1.2 Objectives: .....	2
1.3 Hypotheses: .....	3
CHAPTER 2. LITERATURE REVIEW .....	4
2.1 Migrant Studies.....	4
2.2 Study of cancer incidence patterns among Chinese immigrants in the United States.....	6
2.2.1 Cancer mortality rates of Chinese immigrants in the United States .	6
2.2.2 Cancer incidence rates of Chinese immigrants in the United States. .	7
2.2.3 Cancer incidence pattern of Chinese immigrants in the United States.....	8
2.3 Study of cancer survival pattern among Chinese immigrants in the United States.....	9
2.3.1 Relative survival rates.....	10
2.3.2 Prognostic factors related to survival rates.....	12
2.3.3 Cancer survival pattern of Chinese in the United States.....	15

CHAPTER 3. MATERIAL AND METHODS .....	18
3.0 General.....	18
3.1 SEER Data .....	20
3.1.1 Incident cancer cases: .....	21
3.1.2 Population data: .....	22
3.2 Methods: .....	25
3.2.1 Method for adjusting unknown birthplace data: .....	25
3.2.2 Age-, sex- and site-specific cancer incidence rates: .....	28
3.2.3 Age standardized incidence rates (ASIRs): .....	28
3.2.4 Comparison analysis of incidence rates: .....	29
3.2.4.1 Comparison between white American and Chinese in the US.....	29
3.2.4.2 Comparison between first and second generation Chinese immigrants in the US .....	29
3.2.5 Survival analysis: .....	30
3.2.5.1 Observed survival rates: .....	32
3.2.5.2 Expected survival rates: .....	32
3.2.5.3 Relative survival rates: .....	32
3.2.5.4 Cause-specific survival rates: .....	33
3.2.6 Comparison analysis of survival rates: .....	33
3.2.6.1 Comparisons of distribution by prognostic factors for selected cancer sites among three study groups. ....	34
3.2.6.2 Comparisons of observed, relative, and cause-specific survival rates for selected cancer sites for each study group. .....	34
3.2.6.3 Comparisons of cause-specific survival rates for selected cancer sites for three study groups. ....	35
3.2.7 Cox analysis: .....	36

CHAPTER 4. RESULTS .....	37
4.1 Accuracy of population count estimation: .....	37
4.2 Missing birthplace for cancer cases in SEER data: .....	38
4.3 Age and sex distribution of three study groups in San Francisco, 1975-90. .	39
4.4 Age and sex distribution of all cancer cases for three study populations in San Francisco, 1973-92: .....	39
4.5 Age, sex and time period-specific cancer incidence rates: .....	46
4.5.1 Age, sex and time period-specific crude incidence rates in three study groups: .....	46
4.5.2 Age-Standardized cancer incidence rates: .....	50
4.6 Site-specific cancer incidence rates in three study groups .....	53
4.6.1 Site-specific cancer cases in three study groups: .....	53
4.6.2 Site-specific cancer incidence rates for three study groups. ....	53
4.6.3 Age-Standardized incidence rates of three study groups for selected cancer sites. ....	53
4.7 Age Standardized Incidence Rate Ratios (ASIRR) .....	61
4.7.1 First generation Chinese immigrants Vs US born white Americans	61
4.7.2 Second generation Chinese immigrants Vs US born whites Americans: .....	63
4.7.3 First generation Chinese immigrants Vs second generation Chinese immigrants: .....	63
4.7.4 Summary: .....	63
4.8 Survival Analysis in the three study groups: .....	65
4.8.1 Comparisons of distribution by prognostic factors for selected cancer sites among three study groups. ....	65
4.8.2 Comparisons of observed, relative, and cause-specific survival rates for selected cancer sites within each study population. ....	71
4.8.3 Comparisons of cause-specific survival rates for selected cancer sites for three study groups. ....	80

4.8.4 Cox analysis: .....	84
4.5.8 Summary:.....	96
CHAPTER 5. DISCUSSION: .....	98
5.1 General: .....	98
5.1.1 Study design of this study .....	98
5.1.2 Population Counts for incidence rates .....	100
5.1.3 The Net Survival Rates .....	101
5.2 Limitations for the study .....	105
5.2.1 Absence of data on variables of potential interest. ....	105
5.2.2 Selection bias in migrant studies. ....	106
5.2.3 Representative of SEER data for whole population of US. ....	107
5.3 Analysis of cancer incidence: .....	108
5.3.1 Nasopharyngeal Cancer: .....	108
5.3.2 Esophageal Cancer: .....	109
5.3.3 Stomach Cancer: .....	110
5.3.4 Liver Cancer: .....	111
5.3.5 Colon and Rectum Cancer: .....	113
5.3.6 Lung Cancer: .....	114
5.3.7 Female Breast Cancer: .....	115
5.3.8 Prostate Cancer: .....	117
5.4 Analysis of cancer survival: .....	117
5.4.1 Female Breast Cancer: .....	119
5.4.2 Prostate Cancer: .....	120
5.4.3 Colorectal Cancer: .....	121
5.4.4 Lung Cancer: .....	123
5.4.5 Summary:.....	123
CHAPTER 6. CONCLUSION: .....	125

REFERENCE .....	127
APPENDIX A: Distributions of cancer cases by age, sex and selected cancer sites among Chinese, White and unknown birthplace groups .....	131
APPENDIX B: Procedure of adjustment for unknown birthplace cancer cases.....	136
APPENDIX C: Variable coding sheet for Cox proportional hazard regression .....	144
APPENDIX D: Actuarial method for survival analysis.....	146

## LIST OF TABLES

Table 3.1 Distribution of birthplace in cancer cases for selected race groups, San Francisco (1973-92). . . . .	26
Table 3.2 Distribution of birthplace in census populations for selected race groups, San Francisco ( 1970-90) . . . . .	26
Table 4.0 The precision of the population counts. . . . .	37
Table 4.1 Cancer cases with unknown birthplace by age and sex, SEER, 1973-92. . . . .	38
Table 4.2 Age and sex distributions of U.S. born white Americans in San Francisco, 1975-1990. . . . .	40
Table 4.3 Age and sex distribution of first generation Chinese immigrants in San Francisco, 1970-1990 . . . . .	41
Table 4.4 Age and sex distributions of second generation Chinese immigrants in San Francisco,1970-1990. . . . .	42
Table 4.5 Age and sex distribution of all cancer cases in US born white Americans, San Francisco, 1973-77, 1978-82, 1983-87 and 1988-92. . . . .	43
Table 4.6 Age and sex distribution of all cancer cases in first generation Chinese immigrants, San Francisco, 1973-77, 1978-82, 1983-87 and 1988-92. . . . .	44
Table 4.7 Age and sex distribution of all cancer cases in second generation Chinese immigrants, San Francisco, 1973-77, 1978-82, 1983-87 and 1988-92. . . . .	45
Table 4.8 The age, sex and time period-specific incidence rates per 100,000 person-years of all cancer combined for US born white Americans in San Francisco, 1973-77, 1978-82, 1983-87 and 1988-92. . . . .	47
Table 4.9 The age, sex and time period-specific incidence rates per 100,000 person-years of all cancer combined for first generation Chinese immigrants in San Francisco, 1973-77, 1978-82, 1983-87 and 1988-92 . . . . .	48
Table 4.10 The age, sex and time period-specific incidence rates per 100,000 person years of all cancer combined for second generation Chinese immigrants in San Francisco, 1973-77,1978-82, 1983-87 and 1988-92 . . . . .	49

Table 4.11 World Standard Population (100,000) .....	50
Table 4.12 Age-standardized (world population) cancer incidence rates (ASIR) per 100,000 person-years of all cancer sites and 95% confidence intervals in four study periods for three study groups, San Francisco, SEER 1973-92. .....	51
Table 4.13 Number of cancer cases by site, sex and age groups of US born white Americans in San Francisco, 1973-1992 .....	54
Table 4.14 Number of cancer cases by site, sex and age groups of first generation Chinese immigrants in San Francisco, 1973-1992. . . . .	55
Table 4.15 Number of cancer cases by site, sex and age groups of second generation Chinese immigrants in San Francisco, 1973-1992. . . . .	56
Table 4.16 Site-specific cancer incidence rates (per 100,000) in three study groups in San Francisco, 1973-92. . . . .	57
Table 4.17 Age-Standardized (world population) incidence rates(ASIR) per 100,000 person-years of selected cancer sites and 95% confidence intervals of three study groups for selected sites in San Francisco, 1973-92 .....	59
Table 4.18 Relative risks of cancer in the first and second generation Chinese immigrants and US born white Americans for selected cancer sites for SEER ,1973-92 .....	62
Table 4.19 Distribution of prognostic factors in female breast cancer cases for each study groups. . . . .	66
Table 4.20 Distribution of prognostic factors in prostate cancer cases for each study group .....	67
Table 4.21 Distribution of prognostic factors in colon and rectum cancer cases for each study group. . . . .	68
Table 4.22 Distribution of prognostic factors in lung cancer cases for each study group..	69
Table 4.23 Multivariate survival analyses of patients with female breast cancer in three study groups, SEER 1973-92. . . . .	90
Table 4.24 Multivariate survival analyses of patients with prostate cancer in three study	

groups, SEER 1973-92. ....	91
Table 4.25 Multivariate survival analyses of patients with colon & rectum cancer in three study groups, SEER 1973-92. ....	92
Table 4.26 Multivariate survival analyses of patients with lung cancer in three study groups, SEER 1973-92. ....	93
Table 4.27 Comparison of relative risk for dying from cancer among three study groups, SEER 1973-92 .....	95

## LIST OF FIGURES

Figure 4.1 Age_standardized (world population) cancer incidence rates of all cancers (excluding ICD9-173) for four study periods, San Francisco, SEER, 1973-92 (Male) .....	52
Figure 4.2 Age_standardized (world population) cancer incidence rates of all cancers (excluding ICD9-173) for four study periods, San Francisco, SEER, 1973-92 (Female).....	52
Figure 4.3 Age_standardized (world population) cancer incidence rates of selected sites and 95% confidence intervals for three study groups in San Francisco, SEER, 1972-92 (Male) .....	58
Figure 4.4 Age_standardized (world population) cancer incidence rates of selected sites and 95% confidence intervals for three study groups in San Francisco, SEER, 1972-92 (Female).....	58
Figure 4.5 Female breast cancer survival by stages in first generation Chinese immigrants, SEER, 1973-92.....	73
Figure 4.6 Female breast cancer survival by stages in second generation Chinese immigrants, SEER, 1973-92.....	73
Figure 4.7 Female breast cancer survival by stages in US born white Americans, SEER, 1973-92.....	73
Figure 4.8 Comparison of three survival rates for female breast cancer in second generation Chinese immigrants, SEER, 1973-92 .....	74
Figure 4.9 Comparison of three survival rates for female colon & rectum cancer in second generation Chinese immigrants, SEER, 1973-92 .....	74
Figure 4.10 Comparison of three survival rates for female lung cancer in second generation Chinese immigrants, SEER, 1973-92 .....	74
Figure 4.11 Comparison of three survival rates for prostate cancer in second generation Chinese immigrants, SEER, 1973-92 .....	75
Figure 4.12 Comparison of three survival rates for male colon & rectum cancer in second generation Chinese immigrants, SEER, 1973-92 .....	75

Figure 4.13 Comparison of three survival rates for male lung cancer in second generation Chinese immigrants, SEER, 1973-92 .....	75
Figure 4.14 Comparison of three survival rates for female breast cancer in first generation Chinese immigrants, SEER, 1973-92 .....	76
Figure 4.15 Comparison of three survival rates for female colon & rectum cancer in first generation Chinese immigrants, SEER, 1973-92 .....	76
Figure 4.16 Comparison of three survival rates for female lung cancer in first generation Chinese immigrants, SEER, 1973-92.....	76
Figure 4.17 Comparison of three survival rates for prostate cancer in first generation Chinese immigrants, SEER, 1973-92 .....	77
Figure 4.18 Comparison of three survival rates for male colon & rectum cancer in first generation Chinese immigrants, SEER, 1973-92 .....	77
Figure 4.19 Comparison of three survival rates for male lung cancer in first generation Chinese immigrants, SEER, 1973-92 .....	77
Figure 4.20 Comparison of three survival rates for female breast cancer in US born white Americans, SEER, 1973-92 .....	78
Figure 4.21 Comparison of three survival rates for female colon & rectum cancer in US born white Americans, SEER, 1973-92 .....	78
Figure 4.22 Comparison of three survival rates for female lung cancer in US born white Americans, SEER, 1973-92 .....	78
Figure 4.23 Comparison of three survival rates for prostate cancer in US born white Americans, SEER, 1973-92 .....	79
Figure 4.24 Comparison of three survival rates for male colon & rectum cancer in US born white Americans, SEER, 1973-92 .....	79
Figure 4.25 Comparison of three survival rates for male lung cancer in US born white Americans, SEER, 1973-92 .....	79
Figure 4.26 Comparison of three survival rates for female breast cancer (localized stage) in US born white Americans, SEER, 1973-92.....	81

Figure 4.27 Comparison of three survival rates for female breast cancer (regional stage) in US born white Americans, SEER, 1973-92 .....	81
Figure 4.28 Comparison of three survival rates for female breast cancer (distant stage) in US born white Americans, SEER, 1973-92 .....	81
Figure 4.29 Female breast cancer specific survival rates in three study groups, SEER, 1973-92. ....	82
Figure 4.30 Female breast cancer relative survival rates in three study groups, SEER, 1973-92. ....	82
Figure 4.31 Female breast cancer observed survival rates in three study groups, SEER, 1973-92. ....	82
Figure 4.32 Prostate cancer specific survival rates in three study groups, SEER, 1973-92 .....	83
Figure 4.33 Prostate cancer relative survival rates in three study groups, SEER, 1973-92 .....	83
Figure 4.34 Prostate cancer observed survival rates in three study groups, SEER, 1973-92 .....	83
Figure 4.35 Male colon & rectum cancer specific survival rates in three study groups, SEER, 1973-92 .....	85
Figure 4.36 Male colon & rectum cancer relative survival rates in three study groups, SEER, 1973-92. ....	85
Figure 4.37 Male colon & rectum cancer observed survival rates in three study groups, SEER, 1973-92. ....	85
Figure 4.38 Female colon & rectum cancer specific survival rates in three study groups, SEER, 1973-92. ....	86
Figure 4.39 Female colon & rectum cancer relative survival rates in three study groups, SEER, 1973-92. ....	86
Figure 4.40 Female colon & rectum cancer observed survival rates in three study groups, SEER, 1973-92. ....	86

Figure 4.41 Male lung cancer specific survival rates in three study groups, SEER, 1973-92 .....	.87
Figure 4.42 Male lung cancer relative survival rates in three study groups, SEER, 1973-92 .....	.87
Figure 4.43 Male lung cancer observed survival rates in three study groups, SEER, 1973-92 .....	87
Figure 4.44 Female lung cancer specific survival rates in three study groups, SEER, 1973-92.....	88
Figure 4.45 Female lung cancer relative survival rates in three study groups, SEER, 1973-92.....	88
Figure 4.46 Female lung cancer observed survival rates in three study groups, SEER, 1973-92.....	88

# CHAPTER 1. INTRODUCTION

## 1.1 General:

Studies of diseases in immigrant populations have been popular with epidemiologists. The health status of immigrants after migration usually differs from that of non-migrants. These differences provide an opportunity to separate the influences of genetic and environmental factors on human health.

Immigrant populations are of special interest to the cancer epidemiologist since migration of a population from one environment to another provides an example of a "Natural experiment", allowing the risk of disease to be compared in populations of similar genetic background living in different environments. The most basic comparisons are the risk of cancer in immigrants relative to that of the population of the host country, and relative to that of the country of origin. First generation immigrants (born in the country of origin) can be distinguished from their children, usually born in the host country, who are described as second generation immigrants. This distinction sometimes provides information on the effects of behavior changes resulting from cultural integration, which act more profoundly on the second generation.

Migrant studies of cancer have been conducted in many countries for different ethnic groups. Among the world's major immigrant populations, the Chinese represent a resource for epidemiological investigations on a variety of cancers. The history of cancer studies of

Chinese immigrants in the United States has been about 50 years.

This thesis will take advantage of the information gathered by The Surveillance, Epidemiology and End Results (SEER) Program of The National Cancer Institute (US), and describe cancer incidence and survival patterns among Chinese immigrants in the United States based on newly released data. Since the SEER data provides the information on birthplace and race for each individual, it is possible to defined the three study groups as first generation Chinese, second generation Chinese and US born white American. The incidence rates and survival rates will be compared among these three groups.

## **1.2 Objectives:**

- (1) To examine site-specific cancer incidence patterns for selected cancers among first and second generations of Chinese immigrants as well as US born white Americans.
- (2) To analyze the survival patterns for selected cancers among first and second generation of Chinese immigrants and US born white Americans.
- (3) The secondary objective of this study is to compare three different methods for calculating survival rate.

### **1.3 Hypotheses:**

- (1) Given the importance of genetic factors in the etiology of cancer, Chinese immigrants to the United States will experience site-specific patterns of cancer incidence different from those of US born white Americans.
  
- (2) Given the importance of environmental factors in the etiology of cancer, first generation Chinese immigrants to the United States will experience site-specific patterns of cancer incidence different from those of second generation Chinese immigrants who were born in the United States.
  
- (3) Given the social, culture and environmental factors in the diagnosis and treatment of cancer, first and second generation Chinese immigrants will experience different survival patterns from US born white Americans.

## **CHAPTER 2. LITERATURE REVIEW**

### **2.1 Migrant Studies:**

One of the most important purposes of migrant studies is to distinguish effects of heredity and environment in order to provide etiologic clues. If rates of a cancer in immigrants or their descendants tend to approach those of the country of adoption, at least part of the differences in rates among countries is presumably due to environmental and not hereditary factors. On the other hand, if rates in succeeding generations stabilize at a level different from the rate in the country of adoption, this difference would, in theory, be a measure of the hereditary component of the difference in rates between the countries of origin and adoption<sup>[1]</sup>.

Studies of cancer risk in the offspring of immigrants are also concerned with time as a measure of dose of environmental factors in disease causation. The offspring of immigrants are, of course, exposed to the environment of the host country throughout their entire life (although they may retain some of the lifestyle of their parents). Study of their risk in relation to that of the country of origin, the first generation immigrants, and the local born, provides additional information on the relative importance of childhood and adult environmental exposures in etiology. If rates of a particular cancer in the immigrants themselves approximate those in the country of adoption, then adult environmental exposures are likely to be important determinants of risk. If rates for the second generation, but not those for the first generation approximate those in the country of adoption, early environmental exposure

may be important.

In migrant studies, 'environment' is used to encompass all elements of lifestyle that influence cancer risk. While the aspects of the external environment change abruptly on migration, the aspects of lifestyle will be retained to a greater or lesser degree by immigrant populations in their new surroundings. The change in risk of a cancer according to duration of stay, or to age at migration, can be interpreted in terms of the degree to which immigrants change their lifestyle and the sensitivity of risk to changes in exposure to causative factors<sup>[1]</sup>.

There are three main sources of bias in migrant studies: 1) Since there is considerable variation in rates of cancer within various parts of the country of origin, the rates of different samples of immigrant populations will be quite different. In some situations, the rates also vary markedly by region in the host country. Thus the comparison of the rates among immigrant population, population in the country of origin and population in the country of host can be biased. 2) Selection bias in migrant studies is the result of the immigrant population representing a non-random sample of the population of the country of origin. Immigrants are often assumed to be healthier than the average population (the "healthy migrant effect") either because seeking a new life implies a population that is resourceful and energetic, or by the screening out of the sick and disabled by immigration authorities of the host countries<sup>[1]</sup>. 3) Lack of information on duration of stay or age at migration in cancer registry files leads to difficult interpretation of a high disease rate. For example, high incidence rates of liver cancer in male Chinese immigrants may be caused by genetic determinants, or by some dietary habits which could be carried on by immigrants to their new

host country, or by their early life exposure to hepatitis B infection <sup>[2]</sup>.

## **2.2 Study of cancer incidence patterns among Chinese immigrants in the United States:**

### **2.2.1 Cancer mortality rates of Chinese immigrants in the United States:**

The history of cancer studies of the Chinese population in the United States goes back about 50 years. Smith's review of cancer mortality among Chinese in the US as of 1949-1952 represented the first paper examining cancer in Chinese immigrant groups <sup>[3]</sup>. Smith reported that excess mortality was recorded for cancers of the pharynx, stomach and liver for male Chinese compared to white Americans<sup>[4]</sup>. This study did not distinguish the migrant status between the first and second generations, which is necessary for the research of site-specific transition of risk. The study also lacked comparison rates from China.

Systematic studies by nativity began with two investigations by King, Haenszel, and Locke on the US Chinese in 1959-62 and 1968-72 <sup>[3,5]</sup>. In the absence of comparable homeland data, the cancer mortality experience among Chinese in Hong Kong, Singapore, and /or Taiwan province was used in these two studies to provide comparison risk levels. Taking advantage of the information gathered for the 1975 National Mortality Survey in China, King et al compared the levels of cancer mortality among foreign-born and United States born Chinese around 1970 with those of the communities of origin of the majority of Chinese immigrants to the US <sup>[6]</sup>. Age-adjusted rates indicate two distinctive site-specific patterns among Chinese after immigration to the US: a downward trend for cancers of high

risk among Guangdong and Hong Kong Chinese (nasopharynx, esophagus, liver, uterus), and an upward trend for those sites of low risk among Chinese in Guangdong and Hong Kong (colon, lung, leukemia and female breast) <sup>[6]</sup>.

### **2.2.2 Cancer incidence rates of Chinese immigrants in the United States:**

In the earliest migrant studies, mortality data were almost always used as a proxy for incidence. This is only valid providing the ratio between mortality and incidence is constant for the groups being compared. This may not be the case for international comparisons, since there are apparent differences in survival from cancer between different countries<sup>[7]</sup>. Incidence rates from cancer registries are more internationally comparable than death certificate data, since special efforts are made to achieve this <sup>[8]</sup>. They are also superior to mortality data in providing a measure of the burden in a population <sup>[9]</sup>.

Recently, there were a series of studies of liver, ovarian, thyroid cancer and non-Hodgkin's lymphoma incidence in Asian immigrants to the United States and in their descendants<sup>[10, 11, 12, 13]</sup>. These indicated that liver cancer incidence among Asian Americans was lower than among residents of Asia. Further analysis of the other individual cancer incidence rates revealed substantial variation between Chinese immigrants and the majority of US population. Yu et al compared the incidence rates of cancers of the colon, rectum, prostate, and breast among three groups: the native Chinese in Shanghai, Chinese Americans and white Americans in the United States <sup>[14]</sup>. White Americans had age-adjusted incidence rates of colon cancer four times as high and rates of rectal cancer twice as high as Shanghai

Chinese, whereas in Chinese immigrants the rates were almost equal to the rates of white Americans. Rates of prostate cancer and postmenopausal breast cancer were 26-fold and 10 fold higher, respectively, in whites compared with rates of Shanghai Chinese; Chinese American rates were intermediate <sup>[14]</sup>.

Although cancer data at a national level are regularly available for African Americans and whites, they are published infrequently for other American racial and ethnic populations. In 1996, Miller et al used the SEER registry information to publish a monograph on racial and ethnic patterns of cancer during 1988-1992 that is the most extensive compilation of this type of information published to date <sup>[15]</sup>. The five most commonly diagnosed cancers among Chinese men were: lung bronchus, prostate, colorectal, liver intrahepatic bile duct, and stomach. The five most commonly diagnosed cancers among Chinese women were: breast, colorectal, lung bronchus, and ovary/ corpus uteri. They reported that the Chinese immigrants had lower incidence rates of breast, prostate, and lung cancers than whites. However, Chinese men had higher incidence of liver and stomach cancer than whites <sup>[15]</sup>.

### **2.2.3 Cancer incidence pattern of Chinese immigrants in the United States:**

In general, the cancer patterns are substantially different between Chinese immigrants and white Americans. Cancers of the nasopharynx, esophagus, stomach and liver are common in Chinese, whereas cancers of the breast and prostate are rare. Chinese migrating to the United States have a persistently high risk of nasopharyngeal cancer. Among US born Chinese, the risk of common cancers among native Chinese in China (e.g. nasopharynx,

esophagus, liver etc.) is lower, while the risk of uncommon cancers in native Chinese in China (colon, prostate, and female breast) is higher.

### **2.3 Study of cancer survival patterns among Chinese immigrants in the United States:**

There are two objectives for the estimation of survival rates. One is to compare mortality between various groups of patients or to study survival according to individual characteristics such as sex, age, stage of diseases, and diagnosis or type of treatment in order to identify prognostic factors. Another is to set public health priorities or to provide prognostic information for newly diagnosed patients by describing the survival patterns of a given cancer in a group of patients.

The SEER registries conduct active follow-up of all cancer patients from diagnosis to death. They assess vital status and determine the length of survival of all cancer patients. To identify deaths, the SEER registry staff matches cases annually with deaths recorded in their states and supplements this with matches to the National Death Index. In addition, routine procedures for assessing vital status may also include contacting the patient's physician or hospital of diagnosis and matching to driver's license registration files, voter registration files, city directories, regional telephone directories, and the Health Care Financing Administration files. The ascertainment of deaths is likely to be nearly complete. The available information on each newly diagnosed case includes: selected patient demographics, primary site, morphology, diagnostic confirmation, extent of disease, and the first course of cancer-directed therapy. But no further clinical data, such as diagnosis and

treatment of recurrent and/or metastatic disease, are gathered <sup>[16]</sup>.

### 2.3.1 Relative survival rates:

There are several standard methods analyzing survival after a diagnosis of cancer, including the observed, cause-specific and relative survival rate. An **observed survival rate** measures the proportion of persons surviving regardless of cause of death (basically the proportion of patients surviving for a certain amount of time). It can be calculated using the direct method, the actuarial method (life-table) method, or the Kaplan-Meier Method <sup>[17]</sup>. In computing the observed survival rate, deaths from other causes are treated just like deaths from cancer. Therefore, the observed survival rate should be interpreted as the likelihood of surviving all causes of death (i.e., being alive) for a certain time after cancer diagnosis, not the likelihood of surviving that cancer. The observed survival rates underestimate survival from cancer because they group deaths from all causes in the calculations.

There are two general ways to correct for this. One is to calculate a **cause-specific survival rate** if the registries have good cause of death information (i.e., it is known whether each patient died from the cancer under study). This approach only counts as deaths those patients who died from the cancer under study. Those patients who died from the other causes are withdrawn from the study (i.e. censored). The methods for calculating cause-specific survival rates are the same as the methods for observed survival rates, except that death is defined only for the cancer under study. However, cause-specific survival rate depend closely upon the quality of information available on causes of death. Sometimes, it

is hard to tell whether the cause of death was cancer or whether it was a secondary effects of cancer treatment<sup>[18]</sup>.

For registries where reliable and complete cause of death information is not available, it is possible to do an indirect adjustment for other causes of death by calculating a **relative survival rate**. To account for the risk of dying from other causes, the relative survival rate (RSR) for particular groups of patients are computed by dividing the observed survival rates by the expected (normal) survival rates for the subgroup of the general population with the same gender, race, and age characteristics as the patients subgroup<sup>[19]</sup>. The **expected survival rate** is the probability of a population surviving from year to year specified by age, race, and sex. The expected survival rates can be obtained from standard life expectancy tables. For the US, standard life tables for males and females for various race and ethnic groups are produced periodically. Data on general US population mortality and life expectancy tables is usually obtained from tables published by the National Center for Health Statistics. SEER Registries have access to analytic packages in which relative survival rates are produced using built-in life tables and do not have to calculate rates manually.

The relative survival rate represents the ratio of two survival rates: the survival of the population of patients with cancer (which is the observed rate) divided by the expected survival of the general population. The relative rate attempts to estimate the effect of cancer alone on survival. The relative survival rate has inherent advantages compared to cause-specific survival rates, especially for comparing the survival rates of two or more large groups of patients with cancer. Because the relative rate is a ratio, knowledge of the actual

cause of death for each patient with cancer is not necessary, but only the date of death. Consequently, the relative rate circumvents the problem of inaccurate cause of death coding, or nonavailability of death certificates, and the uncertainty about the cause of death. It requires only the information that the patient had a diagnosis of cancer and was alive or dead at a specified time. Therefore, the relative rate is useful for tumor registers that may not have information on the cause of death for every patient<sup>[20]</sup>.

Since the SEER registries conduct active follow-up of all cancer patients from diagnosis to death, it is possible to compare the results obtained by the relative survival method and those obtained by the cause-specific survival method where deaths not attributable to the disease are taken as censored observations.

### **2.3.2 Prognostic factors related to survival rates:**

Survival following the diagnosis of cancer is determined by both biological factors and nonbiological factors. Biological factors include age, extent of disease, stage at diagnosis, and treatment response; while the nonbiological factors include access to medical care, compliance with therapy and socioeconomic status. Race and ethnicity may potentially influence survival through either biological or nonbiological mechanisms.

For example, a review of the literature suggested that the following factors might be important for assessing differences in black/white survival in the United States: lower prevalence of screening examinations prior to diagnosis; fewer diagnoses of asymptomatic disease; less recognition of symptoms related to cancer; delays in the processing of medical

information within the medical system; understaging of tumors which results in use of less aggressive therapies; differential application of definitive treatment; biological characteristics of tumors; poor health status; poor nutrition; factors like alcoholism that compromise the immune system; treatment compliance; side effects of treatment; difficulty with transportation to screening programmes; diagnostic procedures, and treatment; patient belief systems; social support; medical insurance and coping skills. <sup>[21]</sup>.

There are limited population-based estimates of long-term survival rates. Recently, Wingo and Ries et al expanded their pioneering work of the previous decade by examining survival to 1992 for people diagnosed with cancer between 1974 to 1991 in the SEER Program of nine geographic locations <sup>[22, 23]</sup> . They estimated relative survival at 5, 10, and 15 years after diagnosis of cancer of the breast, prostate, colon and rectum, and lung. Their study provided population-based estimates of long-term survival and confirms black/white, male/female, and stage- and age-specific differences for the breast, prostate, colon and rectum, and lung cancers. For breast cancer survival, they found that white women had better survival than black women. They also found that among white women whose tumors were localized, relative survival appeared to increase with age, a relationship that was not apparent for white women whose disease had spread beyond the breast or for black women. Among women whose breast cancer was localized, those who were diagnosed before age 45 appeared to have poorer relative survival than did women of other ages, regardless of length of follow-up. Among prostate cancer patients, white males had better relative survival than black males for all ages and stages of diseases at diagnosis. Relative survival among men

with regional-stage disease generally increased with age until age 75. The youngest men (45-54 years) and the oldest men (75+ years) appeared to have the poorest survival. The relative survival rates among white colorectal cancer patients were higher than rates among black patients. There were no male /female differences in relative survival among colorectal cancer patients. In general, white males who were 75 years and older and white females who were at least 65 years of age appeared to have slightly lower relative survival than patients who were diagnosed at other ages. Among black males whose tumors were diagnosed at local and regional stages, the youngest and oldest men appeared to have the lowest survival rates; among black females with localized disease, relative survival rates decreased as age increased. Finally, relative survival after a diagnosis of lung cancer was better for females than males; the male/female differences were greater than the black/white differences. Survival decreased as age at diagnosis increased in both white and black , male and female and localized or regional stages. Relative survival after a diagnosis of metastatic lung cancer was less than 5%, regardless of gender, race, or age. Among patients who were younger than age 45 with local-stage of lung cancer, white females had the highest chance of surviving 5 years (75%), followed in order by white males (62%), black females (56%), and black males (46%) [23].

Survival rates differ by cancer site, age, gender, race, stage of cancer at diagnosis, and treatment protocol among other factors. When individual characteristics that might affect survival ('prognostic factors') are available for each case under follow-up, it is usual to assess the specific role played by each factor in the prediction of survival time. Cox

regression is used commonly in epidemiological analyses to identify variables affecting disease, death or survival [24].

### **2.3.3 Cancer survival pattern of Chinese in the United States:**

There are few studies comparing cancer patient survival experience among ethnic groups. Most of these have presented comparisons of survival between white and black patients and have shown consistently higher survival rates among white patients for most cancer sites. Few papers have been published comparing cancer patient survival experience among Chinese and other ethnic groups.

Young et al presented an overall comparison of survival rates among Anglos, Hispanics, Blacks, American Indians, Chinese, Japanese, Filipinos, and Hawaiians for each of the major primary cancer sites [25]. Two measures of survival were used: 1) the relative survival rate, (the ratio of the observed survival rate for the patient group to the expected survival rate for persons in the general population similar to the patient group with respect to age race, sex and calendar year), and 2) the observed survival rate. For calculation of 'normal' life expectancy, life tables were generated for each race, sex, and individual year of age on the basis of data from the National Center for Health Statistics in the United States. They reported that Japanese experienced the highest survival rates and American Indians the lowest for many cancer sites. Survival rates for Chinese were usually quite similar to those for whites. Since data on life expectancy for other ethnic groups have now been developed, it is possible to compute relative survival rates for cancer patients in each of the ethnic

groups included in the SEER Program <sup>[19]</sup>.

Meng et al studied 3345 breast cancer cases diagnosed between 1980 and 1988 in the Hawaii Tumor Registry <sup>[26]</sup>. Ethnicity, stage at diagnosis, geographical residence, and menopausal, marital and socioeconomic status were studied. They found Japanese and Chinese patients were generally diagnosed with less advanced disease. Chinese, Filipino and Japanese cases were more likely to be married. Chinese, Japanese and Caucasian breast cancer cases were in a higher socioeconomic status group when compared to Filipino and native Hawaiian, and this distribution corresponds to the distribution in the United States<sup>[27]</sup>. Almost three-quarters of Chinese patients reside in Honolulu compared to less than half in all other groups. The Cox regression model was used to determine the simultaneous influence of the covariates. After statistical adjustment for covariates, Japanese patients had the highest 5-year survival rate, followed by Chinese and the Caucasians. Native Hawaiian and Filipino women had a higher risk of dying from breast cancer within 5 years than women of other ethnic groups did. They also reported that about 40% of the difference between the lowest and highest in survival probability in ethnic groups can be explained by stage at diagnosis. Marital status had a modest influence on survival, accounting for an additional 5% in the ethnic differences in survival. Meanwhile, menopausal status, socioeconomic status and geographical residence were not related to survival. In their latter study of ethnicity and breast cancer survival in Hawaii, they found being married and of a high socioeconomic status increased survival probability <sup>[28]</sup>.

In summary, there are a few studies comparing cancer patient survival experience

between Chinese and other ethnic groups. Most of them compared the survival of female breast cancer. Generally speaking, the prognostic factors for cancer survival include stage at diagnosis, age, gender, race or ethnicity, extent of disease and access to medical care, compliance with therapy and socioeconomic status. For many cancer sites, Chinese experienced similar survival rates as US whites. White Americans had better survival rates than black Americans. Few studies compare cancer patients' survival experience between first and second generation Chinese immigrants in the United States.

## **Chapter 3. Material and Methods**

### **3.0 General:**

For this project, data from the Surveillance, Epidemiology and End Results Program (SEER) of the National Cancer Institute were used for both the incidence and survival analyses. For the incidence analysis, in order to produce incidence rates, we need a count of the number of cancer cases as well as of the population at risk. The SEER data provide the number of incident cancer cases. However, the SEER project does not provide any counts of the number of Chinese immigrants in the United States. Therefore, an alternative source from the US Census Bureau was used to estimate the population at risk. For the survival analysis, since the SEER program conducts active follow-up for all cancer patients, it is possible to assess vital status and to determine the length of survival, which form the basis for the survival analysis.

The main task of this project is to compare the incidence and survival patterns among three study groups in the United States. The combination of ethnicity and birthplace was used to identify three study groups:

- (1) First generation Chinese immigrants (defined as people with self-reported Chinese race who were born in China. This group is also referred to as the China born Chinese).
  
- (2) Second generation Chinese immigrants ( people with self-reported Chinese race and who were born in the United States. This group is also called the US born

Chinese. This group includes third or other succeeding generations).

(3) US born white Americans ( people with self-reported white race and who were born in the United States - also called US born white).

It was not possible to examine incidence for all cancer sites. Specific cancer sites were selected for study that were either common in one of the study groups or that had displayed big differences, between different study groups in previous studies. The following cancer sites were chosen for the incidence study: Nasopharynx (ICD9-147), Esophagus (ICD9-150), Stomach (ICD9-151), Colon (ICD9-153), Rectum (ICD9-154), Liver (ICD9-155), Lung (ICD9-162), Female Breast (ICD9-174), and Prostate (ICD9-185), 'All cancers combined' (which refers to all cancer sites except basal and squamous skin cancers (ICD9-173)). However, for the survival analysis, since this project was going to estimate the survival for relatively long-term of follow-up years after diagnosis, we need to select cancer site with large number of cases among three study groups. Cancer of the female breast, prostate, colon & rectum and lung are the top three most common cancers for males and females among Chinese and white in the United States <sup>[15]</sup>. Therefore, the survival rates of these four selected cancer sites were compared among the three study groups instead of using all of the cancer sites for incidence study.

### **3.1 SEER Data:**

The SEER Program is a result of the National Cancer Act of 1971, which mandated the collection, analysis and dissemination of data useful in the prevention, diagnosis, and treatment of cancer in the United States. The Cancer Statistics Branch of National Cancer Institute provides the SEER Public-Use CD-ROM to anyone who signs an “appropriate use” agreement. It is mandatory that all research results be presented / published in a manner that ensures no individual can be identified. The current study was based on the SEER Cancer Incidence Public-Use Database, 1973-95 released April 1998. The CD-ROM contained the incidence and follow-up data for patients diagnosed in 1973-95, Census Bureau population estimates for 1973-95, Data dictionaries for SEER data and the SEER\*Stat System (v1.1) [29,30]

Although the SEER database covers just 14% of the US population, by design it includes substantially larger percentages of minority populations (e.g. it includes 43% of US Chinese). The regions with the largest proportions of Chinese in the SEER database are San Francisco/Oakland, Los Angeles, the San Jose / Monterey area, Hawaii, and Seattle/Peugeot Sound. These five regions cover almost all Chinese immigrants (95%) in the SEER database [15]. Over two-thirds of the Chinese population covered by SEER are equally divided between San Francisco/Oakland and Los Angeles. Since the data of Los Angeles, San Jose, and Monterey counties in California began to be included only in 1992, we decided to use only the San Francisco/Oakland data for studies of incidence. For survival analysis, we included all cancer patients diagnosed between 1973-92 and followed to 1995 by the SEER Program

for the three study groups. Since survival analysis only needs counts of cancer cases and does not need counts of the population at risk, to increase the cancer cases, we included cancer cases in the entire SEER Registry instead of only San Francisco area.

### **3.1.1 Incident Cancer Case:**

The SEER\*Stat system provided in the CD-ROM is a statistical package for the analysis of SEER databases. SEER\*Stat was used to extract the cancer cases for US born white Americans and first and second generation Chinese immigrants in San Francisco from 1973-1992. The combination of ethnicity and birthplace was used to identify US born white Americans and first and second generation Chinese immigrants in SEER incident cases. The US born white American incident cases were identified as people who self-reported race of white (race code equal to 01) and who were born in one of the 50 states in the US ( birthplace code between 000-099). The second generation Chinese immigrant cases were identified as people who self-reported race of Chinese (race code equal to 04) and who were born in one of the 50 states in US (birthplace code between 000-099). The first generation Chinese immigrant cases were identified as people who self-reported race of Chinese (race code equal to 04) and who were born in the People's Republic of (P. R.) China, Hong Kong, Taiwan, Tibet, Macao and China not specified ( birthplace code between 681-686). In the population counts race was not presented separately for Taiwanese and other Chinese in the 1970 and 1980 census, and the place of birth was not reported separately for four areas (P. R. China, Hong Kong, Macau and Taiwan) in the 1970 census. The birthplaces of P. R. China, Hong Kong, Taiwan, Tibet, and Macao were pooled to identify the first generation

Chinese incident cancer cases.

Counts of the number of age-, sex- and site-specific cancers for the period 1973-1992 were obtained. The age at diagnosis of cancer was grouped into five age groups: 0-39, 40-49, 50-59, 60-69, and 70+. The large interval at the younger age is due to the low incidence of the selected cancer sites in this age group. The age-specific incidence rates and age standardized incidence rates were calculated to make comparisons among the three study groups. Site-specific incidence rates were calculated for cancer of nasopharynx, esophagus, stomach, colon, rectum, liver, lung, female breast and prostate for both gender and each study group during 1973-92. The whole study period was divided into four time periods: 1973-77, 1978-82, 1983-87 and 1988-92. This yields intervals centered on the US census years (1970, 1980 and 1990). The incidence of all sites combined for each study group in the four time periods was calculated to examine for time trends in incidence.

### **3.1.2 Population Data:**

The SEER Public-Use CD-ROM provided population data from the Census Bureau of US. However, there is a problem in using this data to provide the population count for the Chinese immigrants because the category of race in their population files only includes total blacks, total whites and total non-whites. There was no variable for place of birth in the population count files. Therefore, we used data directly from the US census to provide population counts for Chinese immigrants in the United States.

The national census of the United States, conducted every ten years since 1940,

provides a wide range of demographic data on the American population including age, sex, ethnicity, and place of birth. The Integrated Public Use Microdata Series (IPUMS-98), created by the University of Minnesota in November 1997, was used to extract population counts for US born white Americans and first and second generation Chinese immigrants. The IPUMS consists of high-precision samples of the American population drawn from federal censuses. The IPUMS includes nearly all the detail originally recorded by the census enumeration. It is possible to construct a great variety of tabulations from this file. The IPUMS samples for the years since 1960 were originally created by the Census Bureau as part of each decennial enumeration. The samples used in this study are the 1970 Form 1 Metro sample, 1980 Metro sample, and 1990 Metro sample. The sample density is 1 in 100 for these samples <sup>[31]</sup>.

The data were accessed through an on-line data extraction system, available at the web site (<http://www.ipums.umn.edu>). The following variables were chosen to construct the special tabulations of the three study groups for 1970,1980, and 1990: census year, Metropolitan status, person weight, age, sex, race, birthplace, year of immigration and years in the United States. "Metropolitan status" was used to select population counts only for the San Francisco area. "Person weight" gives the number of individuals in the general population represented by each individual in the sample. From these population count files, US born white Americans were identified as people with a self-reported race of white ( race code 100-120) and born in one of the 50 states in the United States ( birthplace code between 00000-09999). The second generation Chinese immigrant was identified as people with a

self-reported race of Chinese or Taiwanese (race code between 400-410 ) and born in one of the 50 states in the United States (birthplace code between 00000-09999). The first generation Chinese immigrant was identified as people with a self-reported race of Chinese or Taiwanese ( race code between 400-410) and born in P.R. China, Hong Kong, Macau, and Taiwan ( birthplace code between 50000-50040). In the 1970 and 1980 census data, race was not presented separately for Taiwanese and other Chinese, and for 1970 the place of birth was not reported separately for four areas (P. R. China, Hong Kong, Macau and Taiwan). Therefore the birthplaces of P. R. China, Hong Kong, Macau and Taiwan were pooled to identify the first generation Chinese immigrants.

Since the national census in US was only conducted in 1970, 1980 and 1990, the population count for inter-censal years, (e.g. 1975 and 1985), were interpolated based on the population count of census years. The exponential function was used in the interpolation:

$P = e^{(a \cdot T + b)}$  or  $LN P = a \cdot T + b$ , where P is population counts and T is year.

Procedures for interpolation were as follows:

(1) Obtain the population counts for each age and sex group in 1970, 1980, and 1990 for US born white Americans and first and second generation Chinese immigrants by producing frequency table.

(2) Calculate the coefficients (a and b) of the above model for each age and sex group in three study groups by using logarithm linear regression method <sup>[32]</sup>.

(3) Obtain the population counts for 1975 and 1985 in each study group by the age and sex groups. The SPSS software was used to conduct these calculations<sup>[33]</sup>.

### **3.2 Methods:**

#### **3.2.1 Method for adjusting unknown birthplace data:**

Table 3.1 shows the percentage of unknown birthplace in the SEER data for white, Chinese and other races. Since missing data for birthplace were found in SEER data but not in the census files (Table 3.2), adjustment methods were used to avoid underestimating birthplace-specific incidence due to unknown birthplace cases. There is no evidence to suggest that the age, sex, and cancer site distributions for people with unknown birthplace are different from that for cases with the known birthplace (see appendix A; Figure I-IV). It is therefore assumed that the unknown birthplace cancer cases are similar to those with known birthplace. A birthplace frequency adjusting factor based on the cases of known birthplace is applied to adjust the frequency of cases with unknown birthplace.

Procedures for obtaining adjusted cases: (See appendix B Table I-VII)

(1) Produce the age and sex distribution for whites and Chinese for four different birthplaces (the United States, China, unknown place and other places) with cases including unknown birthplace cases. Calculate the total number of cases for each age and sex group (See Table I, Appendix B).

(2) Produce the age and sex distribution for white and Chinese for three different

**Table 3.1 Distribution of birthplace in cancer cases for selected race groups, San Francisco, (1973-92)**

Birthplace	White		Chinese		Unknown		Other		All races	
	Number	%	Number	%	Number	%	Number	%	Number	%
US	164958	63.7	1514	14.3	869	20.1	25317	61.1	192658	61.1
China	548	0.2	6643	62.9	33	0.8	70	0.2	7294	2.3
Unknown	59308	22.9	1912	18.1	3289	76.1	9035	21.8	73544	23.3
Other	34264	13.2	484	4.6	133	3.1	7007	16.9	41888	13.3
Total	259078	100.0	10553	100.0	4324	100.0	41429	100.0	315384	100.0

**Table 3.2 Distribution of birthplace in census population for selected race groups, San Francisco, (1970-90)**

Birthplace	White		Chinese		Others		All races	
	Number	%	Number	%	Number	%	Number	%
1970 Census	2297470	89.2	43857	47.0	386104	88.5	2727431	87.8
US	5314	0.2	36042	38.7	400	0.1	41756	1.3
China	273279	10.6	13322	14.3	49986	11.5	336587	10.8
Other regions	2576063	82.9	93221	3.0	436490	14.1	3105774	100.0
1980 Census	2174714	87.7	52048	36.7	480409	75.6	2707171	83.1
US	3897	0.2	79641	56.2	599	0.1	84137	2.6
China	300737	12.1	10099	7.1	154498	24.3	465334	14.3
Other regions	2479348	76.1	141788	4.4	635506	19.5	3256642	100
1990 Census	2218736	83.7	77493	31.3	550004	69.0	2846233	77.0
US	3913	0.1	135460	54.7	1547	0.2	140920	3.8
China	428831	16.2	34814	14.1	245596	30.8	709241	19.2
Other regions	2651480	71.7	247767	6.7	797147	21.6	3696394	100.0

birthplaces (the United States, China and other places) with cases excluding unknown birthplace cases. Calculate the total cases for each age and sex group (See Table II, Appendix B).

(3) The adjusted cases of one specific age and sex group are equal to the unadjusted cases of this age and sex group multiplied by the ratio of total cases including birthplace unknown cases (from Table I, Appendix B) and the total cases excluding birthplace unknown cases (from Table II, Appendix B) for the same age and sex group. For example in Table III, there are 9568 adjusted cases for US born white Americans, age less than 40, and male. This is equal to the 7008 of unadjusted cases for US born white Americans, age less than 40, and male group multiplied by the ratio  $(10632/7787)$ -- the total cases including birthplace unknown cases / the total cases excluding birthplace unknown cases for the white, age less than 40, and male group.

(4) Calculate the adjusted cases for three birthplaces (The United States, China and other places) and each age and sex group in white and Chinese populations (See Table III and IV, Appendix B).

(5) Use Excel to obtain site- and period-specific adjusted cases for birthplaces of The United States and China in white and Chinese populations (See Table V-VII, Appendix B).

### **3.2.2 Age-, sex- and site-specific cancer incidence rates:**

The age-, sex-, site- and period specific cancer incidence rates were calculated for US born white Americans and first and second generation Chinese immigrants. The numerators are the numbers of age, sex, and site specific cancer cases in the study periods 1973-77, 1978-82, 1983-87 and 1988-92 for the three study groups obtained by SEER\*Stat statistical package. The denominators are the population count of the four study periods (1975, 1980, 1985 and 1990) for the three study groups calculated by multiplying the mid-period population count by five. The underlying assumption was that the population in each age- and sex-group was linearly increasing within each five-year period. The specific rates were calculated using the numerators divided by denominators in corresponding age, sex, and site group for four study periods and three study groups. Microsoft Excel software was used to conduct these calculations.

### **3.2.3 Age standardized incidence rates (ASIRs):**

Age standardized incidence rates (ASIRs) were estimated by the direct method using the weights of the "world standard" population. The calculation of a directly standardized rate uses age-specific rates that have been estimated from observations, that are subject to a certain amount of random variability. This variability affects the standardized rate and can lead to spurious conclusions if the observed difference between standardized rates is in fact mainly due to random variation. In order to evaluate the importance of this kind of variation, the standardized rate should be presented with its standard error or its confidence interval. The standard error and the 95% confidence interval of the ASIRs were calculated using the

Poisson approximation method [8].

### **3.2.4 Comparison analysis of incidence rates:**

#### **3.2.4.1 Comparison between white American and Chinese in the US:**

The age-standardized incidence rate ratios (ASIRRs) for first and second generation Chinese immigrants were calculated by dividing the ASIRs of first or second generation Chinese immigrants by the ASIRs of US born white Americans. This provided comparisons of the ASIRs for selected specific sites between first or second generation Chinese immigrants and US born white Americans. Because of the lack of cases in second generation Chinese immigrants for some study periods and cancer sites, the comparisons were made only for the entire study period (1973-92). Comparison of the ASIRs for selected cancer sites was made between white American and first generation Chinese immigrants or white American and second generation Chinese immigrants. The standard error and confidence interval (95% CI) of the ASIRRs were calculated to test the significance of the ASIRRs. When the 95% CI includes 1.0, the ASIRR is not statistical significant (at  $\alpha=0.05$ ). The formula for calculating the ASIRR was  $ASIR_1 / ASIR_2$ . The 95% confidence interval of ASIRR was obtained using the test-based method:  $(ASIR_1 / ASIR_2)^{1 \pm (Z_{\alpha/2} / X)}$ , and X is defined as  $(ASIR_1 - ASIR_2) / \sqrt{(SE (ASIR_1)^2 + SE (ASIR_2)^2)}$  [34].

#### **3.2.4.2 Comparison between first and second generation Chinese immigrants in the US:**

The ASIRRs of first generation Chinese immigrants were also calculated using second generation Chinese immigrants as the reference group. The ASIRRs were calculated

by dividing the ASIRs of first generation Chinese immigrants by the ASIRs of the second generation Chinese immigrants. The standard error and confidence interval (95% CI) of the ASIRs were calculated to test the significance of the ASIRs by using the same methodology as above<sup>[34]</sup>. The comparisons of the ASIRs for selected cancer sites were made between first and second generation Chinese immigrants in US.

### **3.2.5 Survival analysis:**

Cancer patients diagnosed during 1973-92 by the SEER Program for the three study groups in each SEER Registry were included in the survival analysis. We restricted the analysis to the first diagnosis of primary cancer of the female breast, prostate, lung, colon and rectum. Cases first diagnosed at autopsy and cases for which the death certificate was the only indication of a cancer diagnosis were excluded from analysis. In-situ stage cases were excluded from survival analysis since their survival is expected to be near 100 percent. Patients with unknown stage were also excluded.

The survival analysis was done separately for each stage of cancers. SEER defines the stages as :

- (1) In situ: A noninvasive neoplasm has not penetrated the basement membrane nor extended beyond the epithelial tissue.
- (2) Localized: An invasive neoplasm apparently confined entirely to the organ of origin.

(3) Regional: A neoplasm that has extended beyond the limits of the organ of origin directly into surrounding organs or tissues, into regional lymph nodes, or direct extension and regional lymph node involvement.

(4) Distant: A neoplasm that has spread to parts of the body remote from the primary tumor either by direct extension or by discontinuous metastasis.

(5) Unstaged: A neoplasm for which there is not sufficient information to assign a stage <sup>[29]</sup>.

Only cancer cases diagnosed as the localized, regional and distant stages were used in this analysis.

There were three measures of survival in this study: observed, relative, and cause specific survival rates. Generally, analysis is done separately for each stage of cancer (e.g., localized, regional, and distant). The maximum follow-up period was 15 years. Some rates could not be calculated because all cases had died or had been lost to follow-up at 10 or 15 years after diagnosis for some study groups in some study periods. We used all cases diagnosed between 1973 and 1992 to estimate survival statistics for long-term survival as well as to account for more recent treatment protocols and screening modalities. However, the main disadvantage of this design was that estimates of survival were based on different and improved treatment and screening effects over time.

### **3.2.5.1 Observed survival rates:**

The observed survival rates were computed by using actuarial methods and 1-year intervals. The observed survival rates of gender-, age-, and stage-specific survival at 1 to 15 years after diagnosis of cancer of the female breast, prostate, lung, colon and rectum in US born white Americans, first and second generation Chinese immigrants were calculated separately.

### **3.2.5.2 Expected survival rates:**

Expected survival refers to the survival which would be expected for a person in the absence of a diagnosis of cancer. It is obtained from population-based life tables and is used to estimate the impact of being diagnosed with cancer on survival through the Relative Survival Rate (see next section). The expected survival rates had been generated from the U.S. population: SEER\*Stat contained the expected rate table. Expected survival rates for both white and Chinese were obtained from the expected rate table by matching the cases by race, sex, age, and date at which the age was coded.

### **3.2.5.3 Relative survival rates:**

The relative survival rate is the one of the most common methods used by cancer registries to examine the impact of being diagnosed with cancer on survival [18, 19, 20]. It attempts to estimate the effect of cancer alone on survival by adjusting for the expected survival in people without a diagnosis of cancer. The relative survival rates for particular groups of patients were computed by dividing the observed survival rates by expected survival rates for the subgroup of the general United States population with the same

ethnicity, gender, age and calendar year of observation characteristics as the patient subgroup. SEER\*Stat did the calculation of relative survival rates by using built-in standard life expectancy tables of the United States. The relative survival rates of gender-, age-, and stage-specific survival at 1 to 15 years after diagnosis of cancer of the female breast, prostate, lung, colon and rectum in US born white Americans, first and second generation Chinese immigrants were calculated separately.

#### **3.2.5.4 Cause-specific survival rates:**

The cause-specific survival rates for particular groups of patients were calculated using the actuarial method. Only those deaths that could be attributed to the cancer under study were counted as death cases. Other deaths were considered to be a form of censoring (in the same way as cases lost to follow-up and observations, which were censored at the end of the study). The cause-specific survival rates of gender-, age-, and stage-specific survival at 1 to 15 years after diagnosis of cancer of the female breast, prostate, lung, colon and rectum in US born white Americans, first and second generation Chinese immigrants were calculated separately. SPSS software was used to carry out these calculations.

#### **3.2.6 Comparison analysis of survival rates:**

Demographic and diagnostic data used to predict survival, were restricted to information that was reliably recorded for the entire study period (1973-92). Age at cancer diagnosis was classified into four groups (00-44, 45-64, 65-74, 75+). For some cancers, based on patients' age distribution (e.g. prostate cancer), some age groups were grouped together to obtain enough cases for survival analysis. Race and place of birth were combined

to identify first and second generation Chinese immigrants and US born white Americans. Stage of cancer at diagnosis was defined as three groups (Localized, Regional, and Distant). Treatment data included whether there was any cancer-directed surgery. Because efforts to improve early detection through screening have been increasing during recent years in the United States, the year of diagnosis were grouped as 1973-82 and 1983-92 periods. Other demographic data included marital status of cancer cases and cancer case diagnosed from which SEER registry.

#### **3.2.6.1 Comparisons of distribution by prognostic factors for selected cancer sites among three study groups:**

The percent distributions by gender, age at diagnosis, stage at diagnosis, year of diagnosis, had cancer-directed surgery, the SEER registry in which the cases were diagnosed and marital status at diagnosis of cases for selected cancer sites were compared to examine the possible prognostic factors for cancer survival among the three study groups.

#### **3.2.6.2 Comparisons of observed, relative, and cause-specific survival rates for selected cancer sites for each study group:**

The three survival curves were compared graphically. The comparison with observed survival was done to demonstrate the impact of ignoring expected survival on estimates of post-diagnosis survival. There were two reasons to compare the relative and cause-specific survival curves.

First, the SEER data disc did not provide expected survival probabilities for the Chinese ethnic group. Instead, the SEER\*Stat programme used the expected survival for the

general US population to produce relative survival curves. We were unable to locate any other source of ethnicity-specific life-tables. It is likely that survival experience of Chinese immigrants would be different from the general US population leading to biases in the estimation of the relative survival. Comparison with the cause-specific survival provides an approximate guide to the extent of such bias.

Second, we want to examine the impact of various predictor variables on survival. The method of doing this with relative survival curves is very complex. We decided to adopt an alternate approach based on Cox modeling using cause-specific survival as the primary outcome. A similar approach was adopted by Frost et al <sup>[61]</sup>. The graphical comparison was helpful to demonstrate that the Cox modeling and the relative survival curves were similar.

Therefore, we compared the relative and cause-specific survival rates, as well as observed survival rates in each study group for each selected cancer site. This was done by plotting the three curves on a single graph and comparing the survival curves visually.

### **3.2.6.3 Comparisons of cause-specific survival rates for selected cancer sites for three study group:**

First we compared the cause-specific survival rates among three study groups. For those cancer sites manifesting a difference in overall cause-specific survival rates, we compared cause-specific survival rates in specific subgroups to determine whether this variation could be attributed to differences in age, gender, stage at diagnosis, had cancer-directed surgery, the individual cancer registry, marital status or year of diagnosis across the study groups.

### 3.2.7 Cox regression analysis:

Multivariate survival analysis was conducted using the proportional hazard model proposed by Cox <sup>[24]</sup>. The regression analysis was conducted separately for four different cancer sites: female breast cancer, prostate cancer, male and female colon & rectum cancer and male and female lung cancer. Independent variables in each Cox proportional hazards model included: stage of cancer (localized, regional and distant), age at diagnosis (<45, 45-64, 65-74, and 75+), study groups (first and second generation Chinese immigrants and US born white Americans), had directed surgery, year of diagnosis, cancer registries marital status of patients. Dummy variables were created for stages of cancer, age at diagnosis, study groups and cancer registries. Had directed surgery and year of diagnosis were treated as dichotomous variables. The assumptions of proportional hazard were tested by using the log minus log graphic method for each prognostic factors <sup>[62]</sup>. We had intended to use the backward elimination approach (with P-value=0.20) to build the model, but there were no variables which qualified to be eliminated from the model because they all had significant P-values.

## CHAPTER 4. RESULTS

### 4.1 Accuracy of population count estimation:

Population counts for white Americans can be obtained from two sources. One method is from SEER population files in the CD-ROM. Another is through the on-line data extraction system (IPUMS). The population counts of total whites and all races in San Francisco, from 1970 to 1990 were compared between the two sources to estimate the accuracy of the on-line data extraction method. Table 4.0 shows the comparison of the population counts between the two methods. Using SEER as the reference, we calculated the percentage coverage from IPUMS by using the formula:  $100 - \text{ABS}\{(A-B)/B*100\}$  to measure the precision of the population counts. They are all greater than 98.6%. Therefore, the method we used to extract population counts for three study groups has acceptable validity.

**Table 4.0 The precision of the population counts.**

Year	All Races			White		
	SEER	IPUMS	%*	SEER	IPUMS	%*
1970	3111229	3105774	99.8	2586353	2576063	99.6
1975	3158336	3203027	98.6	2530869	2550617	99.2
1980	3257524	3256642	99.9	2501330	2479348	99.1
1985	3479469	3494347	99.6	2569679	2587690	99.3
1990	3690431	3696394	99.8	2613768	2651480	98.6

*Footnotes: %\* Calculation formula =  $100 - \text{ABS}\{(A-B)/B*100\}$ .*

*A: represent total population counts from IPUMS,*

*B: represent total population counts from SEER CD-ROM.*

#### 4.2 Missing birthplace for cancer cases in SEER data:

Table 4.1 shows the age and sex distribution of cancer cases with unknown birthplace in both white Americans and Chinese immigrants in SEER between 1973-92. For males, the percentage of cancer cases with unknown birthplace increased with age up to group 70+. The high percentage in the very young group is due to the youngest group including more years of age than other age groups. For white females, the percentage of cancer cases with unknown birthplace increased with age, but it is not as obvious as in white males. The percentage of cancer cases with unknown birthplace is similar in each age group (except <40 group) in female Chinese. Overall the differences of percentages of cancer cases with unknown birthplace in each age and sex vary little between white and Chinese in SEER data. However, the total percentages of cancer cases with unknown birthplace in white American patients is 22.9% and 18.1% in Chinese patients (see table 3.1 and Appendix B for the calculations to obtain the adjusted cases for incidence analysis).

**Table 4.1 Cancer cases with unknown birthplace by age and sex, SEER, 1973-92.**

Races	Chinese <sup>1</sup>				White <sup>2</sup>			
	Male		Female		Male		Female	
Age	Number	%	Number	%	Number	%	Number	%
<40	81	11	288	25	2845	13	8827	24
40-49	67	9	218	19	1926	9	5187	14
50-59	139	19	234	20	3550	16	6336	17
60-69	213	29	217	19	6266	28	7887	21
70+	244	33	211	18	7791	35	8693	24
Total	744	100	1168	100	22378	100	36930	100

Footnotes: 1. Cancer patients who has race of Chinese in SEER program.

2. Cancer patients who has race of white in SEER program.

### **4.3 Age and sex distribution of three study groups in San Francisco, 1975-90.**

Tables 4.2-4.4 show the age and sex distribution for US born white Americans and the first and second generation Chinese immigrants in San Francisco, 1975-1990. From the population counts, we see that the second generation Chinese immigrant group is the youngest population among the three study groups. As we know, most of first generation immigrants went abroad as adults. For US born white Americans, the population size was quite stable. However, the size of first generation Chinese immigrants increased very fast: the population in 1990 was almost 3 times the population in 1975. The second generation Chinese immigrants also increased but not as fast as for the first generation Chinese immigrants. The overall person years from 1973-92 for each study group were estimated from population counts for 1975, 1980, 1985 and 1990 multiplied by five. There were an estimated 21,655,220 and 22,516,440 person years follow-up in the male and female US born white Americans. Person years for the first generation Chinese immigrants were 924,270 for males and 914,995 for females. For the second generation Chinese immigrants, the estimated person years were 612,430 for males and 598,170 for females.

### **4.4 Age and sex distribution of all cancer cases for the three study groups in San Francisco, 1973-92:**

Tables 4.5-4.7 show the age and sex distribution of all cancer cases in 1973-77, 1978-82, 1983-87 and 1988-92 for US born white Americans, the first and second generation

**Table 4.2 Age and sex distributions of US born white Americans in San Francisco, 1975-1990.**

Age Years	1975		1980		1985		1990	
	Number	%	Number	%	Number	%	Number	%
Male								
<40	713325	65.1	684044	64.9	679744	62.8	670007	60.9
40-49	134751	12.3	114407	10.9	147088	13.6	170612	15.5
50-59	123659	11.3	120294	11.4	109991	10.2	102284	9.3
60-69	74739	6.8	83821	8.0	82751	7.7	84448	7.7
70+	49456	4.5	51661	4.9	62007	5.7	71955	6.5
Total <sup>1</sup>	1095930	100.0	1054227	100.0	1081581	100.0	1099306	100.0
Female								
<40	700429	61.1	689953	61.6	657321	58.8	631982	56.5
40-49	133787	11.7	104727	9.3	142836	12.8	169754	15.2
50-59	128807	11.2	126389	11.3	109180	9.8	97487	8.7
60-69	95081	8.3	100704	9.0	98280	8.8	97981	8.8
70+	87959	7.7	98714	8.8	109691	9.8	122226	10.9
Total <sup>2</sup>	1146063	100.0	1120487	100.0	1117308	100.0	1119430	100.0

Footnotes: 1. The total population counts for all age in males;

2. The total population counts for all age in females;

**Table 4.3 Age and sex distribution of first generation Chinese immigrants in San Francisco, 1975-1990**

Age	1975		1980		1985		1990	
	Number	%	Number	%	Number	%	Number	%
Male								
<40	12132	45.8	23178	55.2	26556	52.5	34554	52.4
40-49	4057	15.3	6497	15.5	6991	13.8	8320	12.6
50-59	4226	16.0	5596	13.3	6452	12.8	7709	11.7
60-69	3443	13.0	3099	7.4	5643	11.2	8606	13.1
70+	2608	9.9	3596	8.6	4896	9.7	6695	10.2
Total <sup>1</sup>	26466	100.0	41966	100.0	50538	100.0	65884	100.0
Female								
<40	11534	45.4	17189	45.6	23616	46.9	33150	47.6
40-49	4262	16.8	7296	19.4	7790	15.5	9373	13.5
50-59	4060	16.0	5797	15.4	7629	15.1	10257	14.7
60-69	3194	12.6	3998	10.6	6368	12.6	9542	13.7
70+	2332	9.2	3395	9.0	4963	9.9	7254	10.4
Total <sup>2</sup>	25382	100.0	37675	100.0	50366	100.0	69576	100.0

*Footnotes: 1. The total population counts for all age in males;*

*2. The total population counts for all age in females;*

**Table 4.4 Age and sex distributions of second generation Chinese immigrants in San Francisco, 1975-1990.**

Age Years	1975		1980		1985		1990	
	Number	%	Number	%	Number	%	Number	%
Male								
<40	19669	77.7	19382	76.7	25841	79.6	31980	81.1
40-49	2412	9.5	2298	9.1	2691	8.3	2990	7.6
50-59	1642	6.5	2100	8.3	1870	5.8	1820	4.6
60-69	971	3.8	1198	4.7	1384	4.3	1625	4.1
70+	631	2.5	299	1.2	669	2.1	1014	2.6
Total <sup>1</sup>	25325	100.0	25277	100.0	32455	100.0	39429	100.0
Female								
<40	17206	74.8	20275	75.7	24480	77.0	29380	77.2
40-49	3125	13.6	2799	10.5	3528	11.1	4082	10.7
50-59	1466	6.4	2298	8.6	1885	5.9	1820	4.8
60-69	852	3.7	1099	4.1	1126	3.5	1222	3.2
70+	345	1.5	300	1.1	786	2.5	1560	4.1
Total <sup>2</sup>	22994	100.0	26771	100.0	31805	100.0	38064	100.0

*Footnotes: 1. The total population counts for all age in males;*

*2. The total population counts for all age in females;*

**Table 4.5 Age and sex distribution of all cancer cases in US born white Americans, San Francisco, SEER, 1973-77, 1978-82, 1983-87 and 1988-92.**

Age	1973-77		1978-82		1983-87		1988-92		1973-92	
Years	Number	%	Number	%	Number	%	Number	%	Number	%
Male										
<40	1408	6.8	1367	6.7	2983	11.0	3811	12.6	9569	9.7
40-49	1483	7.2	1092	5.3	1840	6.8	2830	9.4	7245	7.4
50-59	4121	19.9	3719	18.2	3778	13.9	3346	11.1	14964	15.2
60-69	6661	32.2	6533	31.9	7736	28.5	7742	25.7	28672	29.1
70+	6988	33.8	7754	37.9	10834	39.9	12438	41.2	38014	38.6
Total <sup>1</sup>	20661	100.0	20465	100.0	27171	100.0	30167	100.0	98464	100.0
Female										
<40	4742	16.2	3896	14.8	3703	11.9	3495	11.8	15836	13.6
40-49	3485	11.9	2469	9.4	3038	9.8	3275	11.0	12267	10.5
50-59	6392	21.9	4777	18.2	4627	14.9	3803	12.8	19599	16.9
60-69	6989	23.9	6592	25.1	7994	25.7	6777	22.8	28352	24.4
70+	7594	26.0	8516	32.4	11748	37.8	12370	41.6	40228	34.6
Total <sup>2</sup>	29202	100.0	26250	100.0	31110	100.0	29720	100.0	116282	100.0

Footnotes: 1. The total cancer cases for all age in males;

2. The total cancer cases for all age in females.

**Table 4.6 Age and sex distribution of all cancer cases in first generation Chinese immigrants, San Francisco, SEER, 1973-77, 1978-82, 1983-87 and 1988-92.**

Age Years	1973-77		1978-82		1983-87		1988-92		1973-92	
	Number	%	Number	%	Number	%	Number	%	Number	%
Male										
<40	32	4.9	35	4.5	48	4.0	84	5.5	199	4.8
40-49	50	7.6	52	6.6	70	5.8	79	5.2	251	6.0
50-59	116	17.7	120	15.3	172	14.3	219	14.3	627	15.0
60-69	184	28.1	217	27.7	333	27.7	428	28.0	1162	27.9
70+	272	41.6	360	45.9	581	48.3	719	47.0	1932	46.3
Total <sup>1</sup>	654	100.0	784	100.0	1204	100.0	1529	100.0	4171	100.0
Female										
<40	52	9.7	96	12.0	91	8.8	147	10.0	386	10.0
40-49	105	19.5	97	12.1	115	11.1	178	12.1	495	12.8
50-59	112	20.8	144	18.0	199	19.2	211	14.3	666	17.3
60-69	127	23.6	168	21.0	241	23.2	314	21.3	850	22.1
70+	142	26.4	295	36.9	393	37.8	627	42.5	1457	37.8
Total <sup>2</sup>	538	100.0	800	100.0	1039	100.0	1477	100.0	3854	100.0

Footnotes: 1. The total cancer cases for all age in males;

2. The total cancer cases for all age in females.

**Table 4.7 Age and sex distribution of all cancer cases in second generation Chinese immigrants, San Francisco, SEER, 1973-77, 1978-82, 1983-87, 1988-92 and 1988-92.**

Age	1973-77		1978-82		1983-87		1988-92		1973-92	
Years	Number	%	Number	%	Number	%	Number	%	Number	%
Male										
<40	20	13.9	29	17.6	29	11.9	40	13.9	118	14.0
40-49	11	7.6	11	6.7	16	6.6	15	5.2	53	6.3
50-59	26	18.1	38	23.0	49	20.2	36	12.5	149	17.7
60-69	28	19.4	33	20.0	56	23.0	102	35.4	219	26.1
70+	59	41.0	54	32.7	93	38.3	95	33.0	301	35.8
Total <sup>1</sup>	144	100.0	165	100.0	243	100.0	288	100.0	840	100.0
Female										
<40	44	19.8	47	21.9	66	23.7	77	22.1	234	22.0
40-49	46	20.7	29	13.5	33	11.8	38	10.9	146	13.7
50-59	63	28.4	54	25.1	57	20.4	57	16.4	231	21.7
60-69	39	17.6	47	21.9	59	21.1	86	24.7	231	21.7
70+	30	13.5	38	17.7	64	22.9	90	25.9	222	20.9
Total <sup>2</sup>	222	100.0	215	100.0	279	100.0	348	100.0	1064	100.0

Footnotes: 1. The total cancer cases for all age in males;

2. The total cancer cases for all age in females.

Chinese immigrants. A total of 98,464 male and 116,282 female cancer cases (including all sites except ICD9-173) were diagnosed in US born white Americans from 1973-92 by SEER San Francisco Registry. During the same time period, cancer was found in 4,171 male and 3,854 female first generation Chinese immigrants and in 840 male and 1,064 female second generation Chinese immigrants in the SEER San Francisco Registry. The age distributions of cancer patients within each study groups were stable among different study periods. But there were more young cases in the second generation Chinese immigrants and fewer young cases in the first generation Chinese immigrants. The higher proportion of young cases in the second generation than in the first generation Chinese immigrants may be caused by higher percentage of young people in second generation Chinese immigrants.

#### **4.5 Age, sex and time period-specific cancer incidence rates:**

##### **4.5.1 Age, sex and time period-specific crude incidence rates in three study groups:**

Tables 4.8-4.10 show the age, sex and time period-specific incidence rates for the US born white Americans and first and second generation Chinese immigrants in San Francisco between 1973-1992. In each study group and individual study period, the incidence rates of all cancer sites combined increase as age increases. In the US born white Americans, the incidence rates for most age groups and all ages combined have increased between 1973-77 and 1988-92 especially for males under age 40. But there were no obvious trends for the male and female groups of the first generation Chinese immigrants. For the second generation Chinese immigrants, there was a trend for incidence to increase in males but not in females.

**Table 4.8 The age, sex and time period-specific incidence rates per 100,000 person-years of all cancer combined for US born white Americans in San Francisco, SEER, 1973-77, 1978-82, 1983-87 and 1988-92.**

Age	1973-77	1978-82	1983-87	1988-92	Total <sup>3</sup>
<b>Male</b>					
<40	39.48	39.97	87.77	113.76	69.67
40-49	220.11	190.9	250.19	331.75	255.62
50-59	666.51	618.32	686.97	654.26	655.99
60-69	1782.47	1558.80	1869.71	1833.55	1760.32
70+	2825.95	3001.88	3494.44	3457.16	3234.15
<b>Total<sup>1</sup></b>	<b>376.89</b>	<b>389.4</b>	<b>502.45</b>	<b>547.89</b>	<b>454.69</b>
<b>Female</b>					
<40	135.40	112.94	112.67	110.60	118.19
40-49	520.98	471.51	425.38	385.85	445.18
50-59	992.49	755.92	847.59	780.21	848.69
60-69	1470.11	1309.18	1626.78	1383.33	1446.36
70+	1726.71	1725.39	2142.02	2024.12	1922.07
<b>Total<sup>2</sup></b>	<b>498.58</b>	<b>466.21</b>	<b>562.98</b>	<b>538.51</b>	<b>516.43</b>

*Footnotes:*

1. The crude rates for all ages in males;
2. The crude rates for all ages in females;
3. The crude rates by age and sex for all study periods (from 1973 to 1992).
4. The cancer cases include all cancers combined with ICD9 code 140-208, excludes site ICD9-173.
5. The rates represented the average rates per year for each time period.

**Table 4.9 The age, sex and time period-specific incidence rates per 100,000 person-years of all cancer combined for first generation Chinese immigrants in San Francisco, SEER, 1973-77, 1978-82, 1983-87 and 1988-92.**

Age	1973-77	1978-82	1983-87	1988-92	Total <sup>3</sup>
<b>Male</b>					
<40	52.75	30.20	36.15	48.62	41.28
40-49	246.49	160.07	200.26	189.9	194.08
50-59	548.98	428.88	533.17	568.17	522.87
60-69	1068.84	1400.45	1180.22	994.65	1117.79
70+	2085.89	2002.22	2373.37	2147.87	2171.40
<b>Total<sup>1</sup></b>	<b>494.22</b>	<b>374.59</b>	<b>479.24</b>	<b>465.97</b>	<b>451.28</b>
<b>Female</b>					
<40	90.17	111.70	77.07	88.69	90.30
40-49	492.73	265.90	295.25	379.81	344.70
50-59	551.72	496.81	521.69	411.43	480.12
60-69	795.24	840.42	756.91	658.14	735.87
70+	1217.84	1737.85	1583.72	1728.70	1623.94
<b>Total<sup>2</sup></b>	<b>422.35</b>	<b>428.40</b>	<b>421.32</b>	<b>434.35</b>	<b>421.20</b>

- Footnotes:*
1. *The crude rates for all ages in males;*
  2. *The crude rates for all ages in females;*
  3. *The crude rates by age and sex for all study periods (from 1973 to 1992).*
  4. *The cancer cases include all cancers combined with ICD9 code 140-208, excludes site ICD9-173.*
  5. *The rates represented the average rates per year for each time period.*

**Table 4.10 The age, sex and time period-specific incidence rates per 100,000 person years of all cancer combined for second generation Chinese immigrants in San Francisco, SEER, 1973-77, 1978-82, 1983-87 and 1988-92.**

Age	1973-77	1978-82	1983-87	1988-92	Total <sup>3</sup>
Male					
<40	20.34	29.92	22.44	25.02	24.36
40-49	91.21	95.74	118.91	100.33	102.01
50-59	316.69	361.90	524.06	395.60	400.97
60-69	576.73	550.92	809.25	1255.38	845.89
70+	1870.05	3612.04	2780.27	1873.77	2303.87
Total <sup>1</sup>	113.72	128.97	149.13	144.56	137.16
Female					
<40	51.14	46.36	53.92	52.42	51.24
40-49	294.40	207.22	187.07	186.18	215.75
50-59	859.48	469.97	604.77	626.37	618.56
60-69	915.49	855.32	1047.96	1407.53	1074.67
70+	1739.13	2533.33	1628.50	1153.85	1484.45
Total <sup>2</sup>	183.53	153.90	169.16	178.65	177.88

- Footnotes:*
1. *The crude rates for all ages in males;*
  2. *The crude rates for all ages in females;*
  3. *The crude rates by age and sex for all study periods (form 1973 to 1992).*
  4. *The cancer cases include all cancers combined with ICD9 code between 140-208, excludes site ICD9-173.*
  5. *The rates represented the average rates per year for each time period.*

#### 4.5.2 Age-Standardized cancer incidence rates:

Table 4.11 presents the world standard population used to calculate the age-standardized incidence rates for each study period and study group<sup>[8]</sup>.

**Table 4.11 World Standard Population (100,000)**

Age	Population	%
<40	68000	68.0
40-49	12000	12.0
50-59	9000	9.0
60-69	7000	7.0
70+	4000	4.0
Total	100000	100.0

*Source: Cancer Incidence in Five Continents, Vol. V. IARC Scientific Publications No.88, 1987.*

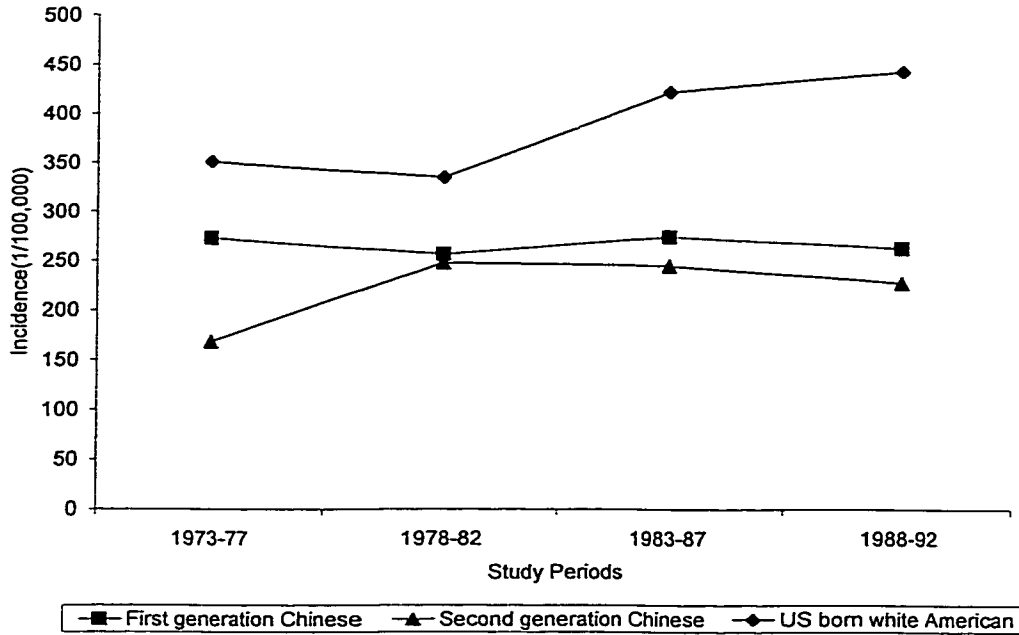
Table 4.12 shows the age standardized incidence rates (ASIRs) and 95% confidence intervals (95% CI) for US born white Americans, the first and second generation Chinese immigrants in four study periods for San Francisco between 1973-1992. Figures 4.1-4.2 show the same information in graphical format. After adjusting for the effects of the different age distributions to overall rates of different study group, the ASIRs of all cancer sites were compared among three study groups. Generally, US white male had the highest ASIRs for all cancers (excluding ICD9-173) in each study period. The ASIRs for all cancer (excluding ICD9-173) for first generation Chinese males were in the middle and close to ASIRs of the second generation Chinese male in the later three study periods. For females, US white Americans also had the highest ASIRs for all cancer (excluding ICD9-173) in each study period. The ASIR curves of the first and second generation Chinese immigrants were very similar.

**Table 4.12 Age-standardized ( world population) cancer incidence rates (ASIR) per 100,000 person-years of all cancer sites , and 95% confidence intervals in four study periods for three study groups, San Francisco, SEER 1973-92.**

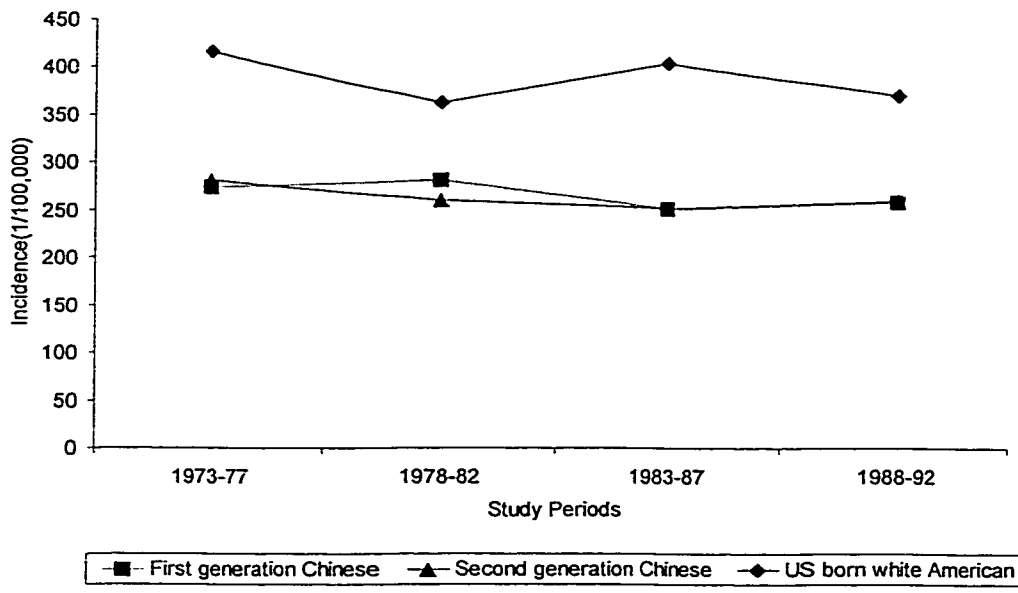
Study Groups	Male			Female		
	US born white Americans	First generation Chinese	Second generation Chinese	US born white Americans	First generation Chinese	Second generation Chinese
1973-77						
ASIR	351.06	273.12	168.45	415.89	274.48	281.11
95% CI	346.26-355.86	250.36-295.88	140.40-196.50	410.97-420.81	249.02-299.94	241.13-321.09
1977-82						
ASIR	334.94	256.47	247.45	362.07	280.92	259.89
95% CI	330.33-339.55	237.5-275.44	204.25-290.65	357.42-366.72	259.32-302.52	219.63-300.15
1983-87						
ASIR	422.19	274.15	244.56	403.5	251.12	252.05
95% CI	329.86-340.02	240.05-272.89	216.07-278.83	357.29-366.85	264.06-297.78	229.2-290.58
1988-92						
ASIR	442.69	262.53	227.48	369.52	258.14	259.04
95% CI	437.57-447.81	248.24-276.82	200.69-254.27	364.93-374.11	243.3-272.98	229.84-288.24
1973-92						
ASIR	389.68	263.53	216.25	388.3	262.44	251.01
95% CI	387.23-392.13	255.02-272.04	201.31-231.19	385.95-390.65	253.23-271.65	235.39-266.63

Footnote: The age-standardized cancer incidence rates include all cancer sites with ICD9 code between 140-208, excludes site ICD9-173.

**Figure 4.1 Age\_standardized (world population) cancer incidence rates of all cancers (excluding ICD9-173) for four study periods, San Francisco, SEER, 1973-92(Male)**



**Figure 4.2 Age\_standardized (world population) cancer incidence rates of all cancers (excluding ICD9-173) for four study periods, San Francisco, SEER, 1973-92(Female)**



#### **4.6 Site-specific cancer incidence rates in three study groups:**

##### **4.6.1 Site-specific cancer cases in three study groups:**

Tables 4.13-4.15 present the cancer cases for the selected cancer sites ( Chapter 3, Section 3.0) by age and sex in three study groups for the entire 20 years (1973-92). Since the numbers of cases for the selected cancer sites were small in second generation Chinese immigrants, it was not possible to examine the selected cancer sites for each study period in this group.

##### **4.6.2 Site-specific cancer incidence rates for three study groups:**

Table 4.16 shows the crude site-specific cancer incidence rates for the selected cancer sites in three study groups for the entire 20 years (1973-92). The site-specific cancer incidence rates are crude rates which are not adjusted for age. The proportion of old age population could bias the overall crude incidence rate of particular study group.

##### **4.6.3 Age-Standardized incidence rates of three study groups for selected cancer sites:**

Figure 4.3-4.4 and Table 4.17 shows the age-standardized incidence rates and their standard errors & 95% confidence intervals of selected cancer sites in three study groups for the entire 20 years in males and females. For males, the first generation Chinese immigrants had the highest ASIRs for nasopharyngeal, stomach and liver cancer, while the US born

**Table 4.13 Number of cancer cases by site, sex, and age groups of US born white Americans in San Francisco, SEER, 1973-1992.**

Site (ICD9)	Male						Female					
	<40	40-49	50-59	60-69	70+	Total <sup>1,3</sup>	<40	40-49	50-59	60-69	70+	Total <sup>2,3</sup>
Nasopharynx(147)	30	13	54	43	32	169	12	12	18	34	25	101
Esophagus (150)	20	63	210	448	469	1221	4	28	124	236	353	794
Stomach (151)	68	120	420	789	1046	2467	39	64	178	350	929	1675
Colon (153)	188	303	1117	2611	4410	8763	129	341	976	2297	6120	10671
Rectum (154)	98	224	704	1441	1719	4224	69	171	498	914	1959	3858
Liver (155)	42	51	144	254	288	783	25	45	66	103	211	468
Lung (162)	235	1147	3923	6949	6759	19129	245	1066	2828	4704	4785	14200
Prostate (185)	4	111	1208	5508	10554	17819	N/A	N/A	N/A	N/A	N/A	N/A
Breast (174)	N/A	N/A	N/A	N/A	N/A	N/A	2700	5552	6834	7955	9508	32546
others	8884	5213	7184	10627	12737	43889	12613	4987	8075	11760	16338	51969
All Sites,(140-208, Except 173)	9569	7245	14964	28670	38014	98464	15836	12266	19597	28353	40228	116282

Footnotes: 1. The total cancer cases for all age in males;

2. The total cancer cases for all age in females.

3. The total is not obtained by summation of individual age groups.  
(Refer to section 3.2.1 and Appendix B adjustment for unknown birthplace cancer cases).

**Table 4.14 Number of cancer cases by site, sex, and age groups of first generation Chinese immigrants in San Francisco, SEER, 1973-1992.**

Site (ICD9)	Male						Female					
	<40	40-49	50-59	60-69	70+	Total <sup>1,3</sup>	<40	40-49	50-59	60-69	70+	Total <sup>2,3</sup>
Nasopharynx(147)	39	59	60	52	12	211	42	33	36	19	10	125
Esophagus (150)	1	5	19	29	46	101	0	0	4	7	10	23
Stomach (151)	9	15	38	53	103	218	10	10	18	33	77	154
Colon (153)	10	15	57	110	273	471	12	16	67	84	205	401
Rectum (154)	4	9	29	73	112	227	2	14	17	58	77	176
Liver (155)	28	37	101	113	95	367	7	6	18	30	47	110
Lung (162)	8	34	144	327	445	962	12	17	78	141	281	556
Prostate (185)	0	1	7	94	304	416	N/A	N/A	N/A	N/A	N/A	N/A
Breast (174)	N/A	N/A	N/A	N/A	N/A	N/A	99	185	165	170	182	772
others	100	76	172	312	542	1198	202	214	262	307	567	1537
All Sites,(140-208, Except 173)	199	251	627	1163	1932	4171	386	495	665	849	1456	3854

Footnotes: 1. The total cancer cases for all age in males;

2. The total cancer cases for all age in females.

3. The total is not obtained by summation of individual age groups.  
(Refer to section 3.2.1 and Appendix B adjustment for unknown birthplace cancer cases).

**Table 4.15 Number of cancer cases by site, sex, and age groups of second generation Chinese immigrants in San Francisco, SEER, 1973-1992.**

Site (ICD9)	Male						Female					
	<40	40-49	50-59	60-69	70+	Total <sup>1,3</sup>	<40	40-49	50-59	60-69	70+	Total <sup>2,3</sup>
Nasopharynx(147)	13	7	7	4	1	30	5	3	1	1	2	12
Esophagus (150)	0	2	8	6	9	26	0	0	1	2	2	7
Stomach (151)	0	1	8	7	13	30	0	0	1	5	10	19
Colon (153)	4	4	10	22	41	82	3	1	11	23	41	88
Rectum (154)	3	2	6	26	17	54	2	0	9	12	9	35
Liver (155)	0	6	14	14	17	52	3	0	0	5	11	21
Lung (162)	8	10	37	50	55	161	5	6	30	36	21	103
Prostate (185)	0	0	8	28	57	96	N/A	N/A	N/A	N/A	N/A	N/A
Breast (174)	N/A	N/A	N/A	N/A	N/A	N/A	64	74	73	72	46	324
others	90	21	51	62	91	311	152	62	105	75	80	455
All Sites,(140-208, Except 173)	118	53	149	219	301	840	234	146	231	231	222	106

Footnotes: 1. The total cancer cases for all age in males;

2. The total cancer cases for all age in females.

3. The total is not obtained by summation of individual age groups.

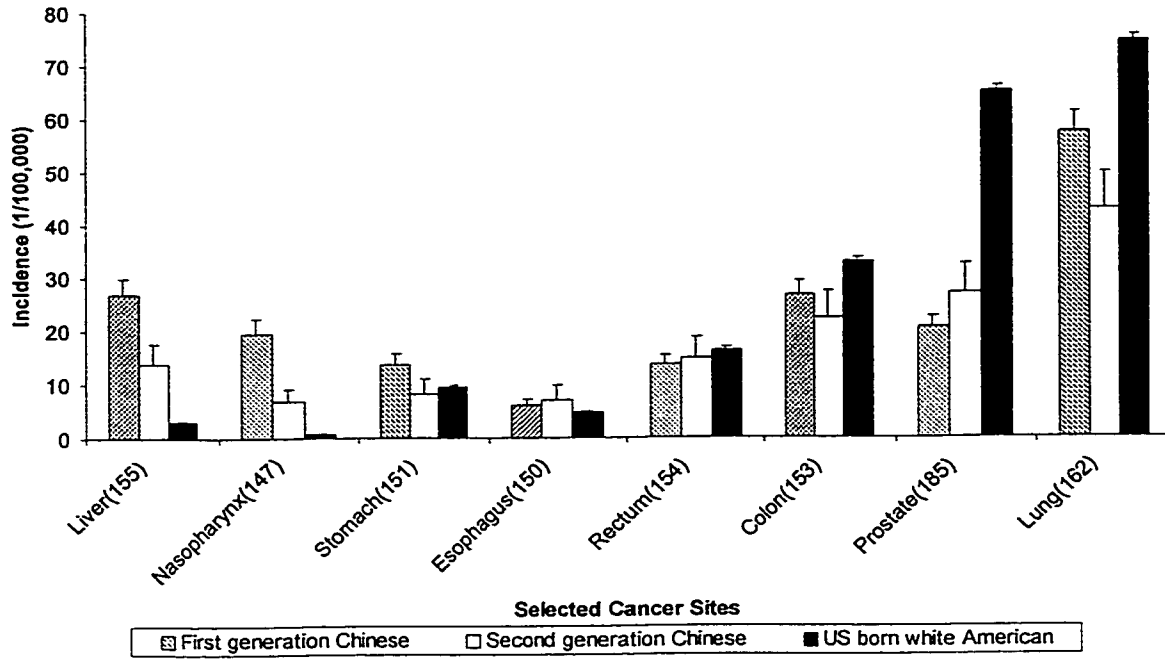
( Refer to section 3.2.1 and Appendix B adjustment for unknown birthplace cancer cases.

**Table 4.16 Site-specific cancer incidence rates (per 100,000) in three study groups in San Francisco, SEER, 1973-92.**

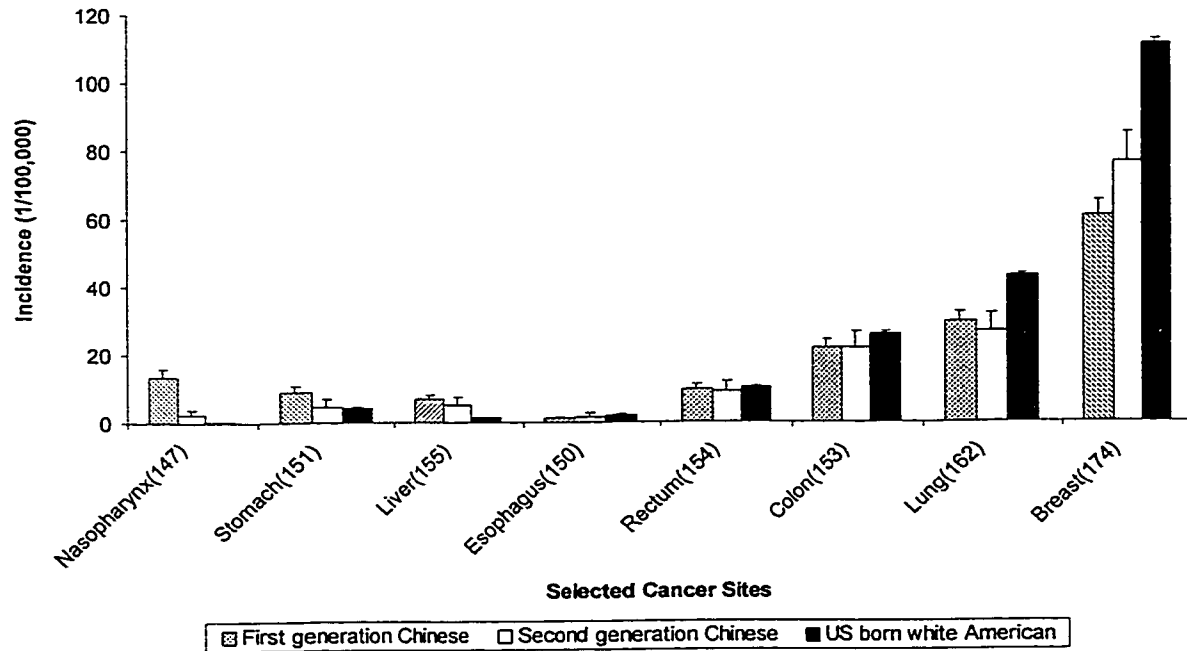
Sites(ICD9)	Male			Female		
	US born white Americans	First generation Chinese	Second generation Chinese	US born white Americans	First generation Chinese	Second generation Chinese
Nasopharynx(147)	0.78	22.94	4.90	0.45	13.88	2.01
Esophagus (150)	5.64	10.93	4.25	3.53	2.51	1.00
Stomach (151)	11.39	23.69	4.90	7.44	17.16	3.01
Colon (153)	40.47	51.07	13.23	47.39	44.59	14.21
Rectum (154)	19.51	24.67	8.82	17.13	19.56	5.52
Liver (155)	3.62	39.92	8.33	2.08	12.24	3.51
Lung (162)	88.33	104.51	25.96	63.07	61.64	16.55
Prostate (185)	82.29	45.22	15.51	N/A	N/A	N/A
Breast (174)	N/A	N/A	N/A	144.54	85.68	52.33
All Sites,(140-208, Except 173)	454.69	451.28	137.16	516.43	421.20	177.88

*Footnote: The site-specific cancer incidence rates are crude incidence rates.*

**Figure 4.3 Age standardized (world population) cancer incidence rates of selected sites and 95% confidence intervals for three study groups in San Francisco, SEER,1973-92 (Male)**



**Figure 4.4 Age standardized (world population) cancer incidence rates of selected sites and 95% confidence intervals for three study groups in San Francisco, SEER, 1973-92 (Female)**



**Table 4.17 Age-Standardized (world population) incidence rates (ASIR) per 100,000 person-years of selected cancer sites and 95% confidence intervals for three study groups in San Francisco, SEER, 1973-92.**

Selected Sites	US born white Americans			First generation Chinese			Second generation Chinese		
	ASIR	95% CI	ASIR	95% CI	ASIR	95% CI	ASIR	95% CI	
<b>Male</b>									
Selected Sites(ICD9)	ASIR	95% CI	ASIR	95% CI	ASIR	95% CI	ASIR	95% CI	
Nasopharynx (147)	0.71	0.61	0.81	19.51	16.82	22.2	6.76	4.37	9.15
Esophagus (150)	4.73	4.46	5.00	6.05	4.82	7.28	7.01	4.31	9.71
Stomach (151)	9.46	9.09	9.83	13.71	11.77	15.65	8.04	5.10	10.98
Colon (153)	32.85	32.14	33.56	26.76	24.21	29.31	22.4	17.46	27.34
Rectum (154)	16.25	15.76*	16.74	13.54	11.7	15.38	14.79	10.83	18.75
Liver (155)	3.07	2.85	3.29	26.84	23.96	29.72	13.76	9.96	17.56
Lung (162)	74.36	73.3	75.42	57.12	53.38	60.86	42.75	36.05	49.45
Prostate (185)	64.85	63.89	65.81	20.62	18.58	22.66	26.96	21.47	32.45
All sites (140-208, Except 173)	389.68	387.23	392.13	263.53	255.02	272.04	216.25	201.31	231.19
<b>Female</b>									
Nasopharynx (147)	0.35	0.27	0.43	13.38	10.95	15.81	2.37	0.96	3.78
Esophagus (150)	2.13	1.97	2.29	1.13	0.64	1.62	1.42	0.17	2.67
Stomach (151)	4.20	3.98	4.42	9.03	7.42	10.64	4.54	2.31	6.77
Colon (153)	25.84	25.29	26.39	21.83	19.5	24.16	21.74	16.9	26.58
Rectum (154)	10.04	9.69	10.39	9.53	8.02	11.04	8.79	5.69	11.89
Liver (155)	1.36	1.22	1.50	6.71	5.32	8.10	5.02	2.71	7.33
Lung (162)	42.84	42.1	43.58	29.46	26.81	32.11	26.37	21.06	31.68
Breast (174)	111.09	109.84	112.34	60.33	55.74	64.92	76.31	67.76	84.86
All sites (140-208, Except 173)	388.3	385.95	390.65	262.44	253.23	271.65	251.01	235.39	266.63

*Footnote: The age-standardized cancer incidence rates for all sites include all cancer sites with ICD9 code between 140-208, excludes site ICD9-173.*

whites Americans had the lowest ASIRs of nasopharyngeal and liver cancer. In contrast, the US born white Americans had the highest ASIRs of colon, lung and prostate cancer, whereas the lowest ASIR of prostate cancer was in the first generation Chinese immigrants. The ASIRs of nasopharyngeal, liver, and prostate cancer for the second generation Chinese immigrants were in the middle-- the ASIR of prostate cancer for the second generation Chinese immigrants was higher than that for the first generation Chinese immigrants and the ASIRs of nasopharyngeal and liver cancer for the second generation Chinese immigrants were higher than that for the US born white Americans. For females, the first generation Chinese immigrants had the highest ASIR for nasopharyngeal cancer, and the US born white Americans had the lowest ASIR for nasopharyngeal cancer. In contrast, the US born white Americans had the highest ASIRs for breast and lung cancers, whereas the lowest ASIR for breast cancer was in the first generation Chinese immigrants. The ASIR of breast cancer in the second generation Chinese immigrants was higher than that in first generation Chinese immigrants and the ASIR for nasopharyngeal cancer in the second generation Chinese immigrants was higher than that in the US born white Americans. There were no difference in the ASIRs of esophagus and rectal cancers among three study groups in males or females.

Within each study group, there were some differences between males and females. For US born white Americans, the ASIRs of nasopharyngeal, esophagus, stomach, colon, rectum, liver, and lung cancers were higher in males than in females. However, the all cancer (excluding ICD9-173) ASIR was not different between males and females in the US born white Americans. There was the same pattern in the first generation Chinese immigrants as

in the US born white Americans -- the ASIRs of nasopharyngeal, esophagus, stomach, colon, rectum, liver, and lung cancers were higher in males than in females. The all cancer (excluding ICD9-173) ASIR was not different between male and female first generation Chinese immigrants. For the second generation Chinese immigrants, the ASIRs of nasopharyngeal, esophagus, liver, and lung cancers were higher in males than in females. The all cancer (excluding ICD9-173) ASIR was higher in females than in males in the second generation Chinese immigrants.

#### **4.7 Age Standardized Incidence Rate Ratios (ASIRR):**

Table 4.18 presents the relative risks of cancer in the first and second generation Chinese immigrants and US born white Americans for selected cancer sites during 1973-92 time periods. Three comparisons were made between the first generation Chinese immigrants and US born white Americans, the second generation Chinese immigrants and US born white Americans and between the first and second generation Chinese immigrants.

##### **4.7.1 First generation Chinese immigrants vs US born white Americans:**

The ASIRRs of nasopharyngeal, esophagus, stomach and liver cancers were significantly greater than '1' in males. Meanwhile, the ASIRRs of colon, rectum, lung, prostate and all cancers (excluding ICD9-173) were significantly less than '1' in males. For

**Table 4.18 The relative risks of cancer in the first and second generation Chinese immigrants and US born white Americans for selected cancer sites, SEER, 1973-92.**

Sites (ICD9)	First generation Chinese		Second generation Chinese vs		First generation vs Second			
	ASIRR	95% CI	ASIRR	95% CI	ASIRR	95% CI		
Male								
Nasopharynx (147)	27.48	17.12	44.12*	3.90	23.22*	2.89	2.14	3.90*
Esophagus (150)	1.28	1.01	1.62*	0.93	2.36	0.86	0.54	1.37
Stomach (151)	1.45	1.22	1.72*	0.61	1.19	1.71	1.23	2.39*
Colon (153)	0.81	0.74	0.89*	0.68	0.82*	1.19	0.95	1.49
Rectum (154)	0.83	0.73	0.95*	0.91	1.18	0.92	0.69	1.23
Liver (155)	8.74	6.71	11.38*	4.48	7.64*	1.95	1.53	2.49*
Lung (162)	0.77	0.73	0.82*	0.57	0.64*	1.34	1.15	1.57*
Prostate (185)	0.32	0.30	0.34*	0.42	0.48*	0.76	0.59	0.98*
Allsites, (140-208, Expect 173)	0.68	0.66	0.7*	0.55	0.58*	1.22	1.13	1.31*
Female								
Nasopharynx (147)	38.23	19.37	75.45*	6.77	25.81*	5.65	3.63	8.79*
Esophagus (150)	0.53	0.38	0.73*	0.67	1.37	0.80	0.28	2.25
Stomach (151)	2.15	1.66	2.78*	1.08	1.80	1.99	1.31	3.03*
Colon (153)	0.84	0.76	0.93*	0.84	1.03	1.00	1.00	1.00
Rectum (154)	0.95	0.81	1.11	0.88	1.21	1.08	0.75	1.55
Liver (155)	4.93	3.25	7.48*	3.69	8.43*	1.34	0.84	2.14
Lung (162)	0.69	0.64	0.74*	0.62	0.72*	1.12	0.90	1.39
Breast (174)	0.54	0.51	0.57*	0.69	0.76*	0.79	0.68	0.91*
Allsites, (140-208, Expect 173)	0.68	0.66	0.70*	0.65	0.68*	1.05	0.97	1.13

Footnote: \* At  $\alpha=0.05$  level, 95% confidence interval did not include 1

females, the ASIRRs of nasopharyngeal, stomach and liver cancers were significantly greater than '1' and the ASIRRs of esophagus, colon, lung, breast and all cancers (excluding ICD9-173) were significantly less than '1'.

#### **4.7.2 Second generation Chinese immigrants vs US born white Americans:**

The ASIRRs of nasopharyngeal and liver cancers were significantly greater than '1' in males. Meanwhile, the ASIRRs of colon, lung, prostate and all cancers (excluding ICD9-173) were significantly less than '1' in males. For females, the ASIRRs of nasopharyngeal and liver cancers were significantly greater than '1' and the ASIRRs of lung, breast and all cancers (excluding ICD9-173) were significantly less than '1'.

#### **4.7.3 First generation Chinese immigrants vs second generation Chinese immigrants:**

The ASIRRs of nasopharyngeal, stomach, liver and overall cancers were significantly greater than '1' in males. Only the ASIRRs of prostate cancer were significantly less than '1' in males. For females, the ASIRRs of nasopharyngeal and liver cancers were significantly greater than '1' and the ASIRRs of breast were significantly less than '1'.

#### **4.7.4 Summary:**

The results from this project show some interesting findings. First, the incidence rates for second generation Chinese immigrants were intermediate between the rates for first generation Chinese immigrants and for US born white Americans in many selected cancer

sites. In males, the second generation Chinese males had a higher risk of developing nasopharyngeal and liver cancers than the US born white males, but a lower risk than first generation Chinese males. On the other hand, the second generation Chinese males had a higher risk of developing prostate cancers than the first generation Chinese males, but a lower risk than US born white males. In females, the second generation Chinese females had a greater chance of developing nasopharyngeal cancer than US born white females, but a lower chance of developing this cancer than the first generation Chinese females. However, the second generation Chinese females had a greater chance of developing breast cancer than the first generation Chinese females, but a lower chance of developing this cancer than US born white females. Second, there are big differences in the relative risks for developing specific cancers between Chinese immigrants and US born white Americans. In males, both first and second generation Chinese male immigrants had a higher chance of developing nasopharyngeal and liver cancers and a lower chance of developing colon, lung and prostate cancers than that of US born white males. Similarly, first and second generation Chinese female immigrants had a higher chance of developing nasopharyngeal and liver cancers and a lower chance of developing lung and breast cancers than that of US born white females. Third, there were more differences in terms of developing specific cancers between US born white Americans and first generation Chinese immigrants than between US born white Americans vs second generation Chinese immigrants. The relative risks of almost all selected cancers in males and females were significantly different between first generation Chinese immigrants and US born white Americans.

#### **4.8. Survival Analysis in the three study groups:**

##### **4.8.1 Comparisons of distribution by prognostic factors for selected cancer sites among three study groups:**

In order to examine the possible prognostic factors for cancer survival, Tables 4.19-4.22 compare some characteristics of cancer patients among the three study groups ( gender, age at diagnosis, stage at diagnosis, year of diagnosis, whether had directed surgery, from which SEER registry the patients were diagnosed and marital status at diagnosis).

During the study period 1973-1992, 115,632 female breast cancer cases, 85,553 prostate cancer cases, 114,567 colon & rectum cancer cases, and 132,648 lung cancer cases were identified from the entire SEER registry for members of the three study groups.

The majority of female breast or prostate cancer patients were diagnosed at the localized and regional stages (91% and 80% respectively). Colon or rectum cancer patients were somewhat less commonly diagnosed at the localized and regional stages (75%), while only 51% of lung cancer patients were diagnosed at the localized and regional stages. Patients with breast, colon or rectum cancer often had directed surgery during their first course of therapy (above 90%). About 68% of prostate and 27% of lung cancer patients had directed surgery during their first course of therapy. People diagnosed with breast cancer were younger than other cancer patients, whereas prostate cancer patients were older than other cancer patients. About 59.5% of the prostate cancer patients were diagnosed between 1983-1992, while 40.5% of the prostate patients were diagnosed between 1973-1982.

**Table 4.19 Distribution of prognostic factors in female breast cancer cases for three study groups, SEER, 1973-92.**

Breast Cancer	Second generation Chinese	First generation Chinese	US born white	Total <sup>1</sup>
Number of cases	543	618	114471	115632
Age at diagnosis				
0-44	16.2%	23.8%	12.6%	12.6%
45-64	49.2%	41.6%	41.8%	41.8%
65-74	21.5%	21.0%	24.3%	24.2%
>74	13.1%	13.6%	21.4%	21.3%
Statistical Test	X <sup>2</sup> = 112.9      df=6		P<0.05	
Stage at diagnosis				
Localized	60.0%	55.5%	51.0%	51.0%
Regional	33.9%	37.2%	40.4%	40.4%
Distant	6.1%	7.3%	8.6%	8.6%
Statistical Test	X <sup>2</sup> = 23.6      df=4		P<0.05	
Year of diagnosis				
1973-1982	42.2%	34.3%	48.3%	48.2%
1983-1992	57.8%	65.7%	51.7%	51.8%
Statistical Test	X <sup>2</sup> =56.3      df=2		P<0.05	
Directed Surgery				
No directed surgery	5.5%	7.1%	5.7%	5.7%
Directed surgery	94.5%	92.9%	94.3%	94.3%
Statistical Test	X <sup>2</sup> =2.4      df=2		P=0.30	
SEER Registries				
San Francisco-Oakland	35.2%	77.5%	15.8%	16.2%
Connecticut	0.6%	1.9%	22.0%	21.8%
Metropolitan Detroit	0.4%	2.1%	14.4%	14.3%
Hawaii	62.2%	11.0%	1.5%	1.8%
Iowa	0.0%	0.2%	14.9%	14.8%
New Mexico	0.2%	0.3%	5.0%	5.0%
Seattle(Puget Sound)	1.3%	6.1%	15.3%	15.2%
Utah	0.0%	0.5%	4.2%	4.1%
Metropolitan Atlanta	0.2%	0.3%	6.9%	6.8%
Statistical Test	X <sup>2</sup> =13447.3      df=16		P<0.05	
Marital Status				
Single	14.2%	6.1%	8.3%	8.3%
Married	61.1%	64.4%	56.5%	56.6%
Separated/divorced/widowed	24.3%	26.9%	33.3%	33.2%
Unknown	0.4%	2.6%	1.9%	1.9%
Statistical Test	X <sup>2</sup> =63.8      df=6		P<0.05	

Footnote: 1. Total includes cancer cases for all three study groups.

**Table 4.20 Distribution of prognostic factors in prostate cancer cases for each study groups, SEER, 1973-92.**

Prostate Cancer	Second generation Chinese	First generation Chinese	US born white	Total <sup>1</sup>
Number of cases	345	364	84844	85553
Age at diagnosis				
0-44	0%	0%	0.1%	0.1%
45-64	13.0%	9.1%	19.2%	19.1%
65-74	48.1%	35.7%	41.4%	41.4%
>74	38.8%	55.2%	39.3%	39.4%
Statistical Test	X <sup>2</sup> =57.0 df=6		P<0.05	
Stage at diagnosis				
Localized	59.7%	54.1%	63.2%	63.2%
Regional	17.7%	23.9%	17.2%	17.2%
Distant	22.6%	22.0%	19.6%	19.6%
Statistical Test	X <sup>2</sup> = 17.6 df=4		P<0.05	
Year of diagnosis				
1973-1982	27.0%	28.3%	40.6%	40.5%
1983-1992	73.0%	71.7%	59.4%	59.5%
Statistical Test	X <sup>2</sup> =48.9 df=2		P<0.05	
Directed Surgery				
No directed surgery	40.3%	28.8%	31.7%	31.7%
Directed surgery	59.7%	71.2%	68.3%	68.3%
Statistical Test	X <sup>2</sup> =13.1 df=2		P<0.05	
SEER Registries				
San Francisco-Oakland	19.4%	78.0%	13.2%	13.5%
Connecticut	0.6%	0.5%	15.5%	15.4%
Metropolitan Detroit	0.0%	0.8%	12.5%	12.4%
Hawaii	77.1%	13.2%	1.6%	2.0%
Iowa	0.0%	0.3%	18.8%	18.7%
New Mexico	0.3%	0.0%	7.5%	7.5%
Seattle(Puget Sound)	2.0%	5.5%	18.3%	18.2%
Utah	0.3%	0.3%	6.7%	6.7%
Metropolitan Atlanta	0.3%	1.4%	5.8%	5.7%
Statistical Test	X <sup>2</sup> =11922.1 df= 16		P<0.05	
Marital Status				
Single	8.7%	3.6%	5.7%	5.7%
Married	77.4%	78.0%	75.8%	75.8%
Separated/divorced/widowed	13.3%	14.8%	16.0%	16.0%
Unknown	0.6%	3.6%	2.5%	2.5%
Statistical Test	X <sup>2</sup> = 17.2 df=4		P<0.05	

Footnote: 1. Total includes cancer cases for all three study groups.

**Table 4.21 Distribution of prognostic factors in colon and rectum cancer cases for each study groups, SEER, 1973-92.**

Colon & Rectum Cancer	Second generation Chinese	First generation Chinese	US born white	Total <sup>1</sup>
Number of cases	561	1025	112981	114567
Sex				
Male	57.2%	56.5%	50.7%	50.7%
Female	42.8%	43.5%	49.3%	49.3%
Statistical Test	X <sup>2</sup> =23.2 df=1		P<0.05	
Age at diagnosis				
0-44	4.1%	4.4%	2.9%	3.0%
45-64	30.8%	27.0%	29.5%	29.5%
65-74	34.8%	32.2%	32.7%	32.8%
>74	30.3%	36.4%	34.8%	34.8%
Statistical Test	X <sup>2</sup> =17.0 df=6		P<0.05	
Stage at Diagnosis				
Localized	39.8%	34.1%	34.2%	34.3%
Regional	39.8%	43.6%	40.8%	40.8%
Distant	20.5%	22.2%	25.0%	24.9%
Statistical Test	X <sup>2</sup> =14.7 df=4		P<0.05	
Year of diagnosis				
1973-1982	42.6%	35.3%	48.5%	48.3%
1983-1992	57.4%	64.7%	51.5%	51.7%
Statistical Test	X <sup>2</sup> =78.1 df=2		P<0.05	
Directed Surgery				
No directed surgery	6.6%	9.4%	9.9%	9.9%
Directed surgery	93.4%	90.6%	90.1%	90.1%
Statistical Test	X <sup>2</sup> =7.0 df=2		P<0.05	
SEER Registries				
San Francisco-Oakland	29.6%	78.9%	13.7%	14.3%
Connecticut	0.4%	0.9%	22.2%	21.9%
Metropolitan Detroit	0.2%	2.0%	15.4%	15.2%
Hawaii	68.1%	10.5%	1.2%	1.6%
Iowa	0.0%	0.3%	20.3%	20.0%
New Mexico	0.4%	0.2%	4.6%	4.6%
Seattle (Puget Sound)	1.1%	6.3%	13.4%	13.2%
Utah	0.2%	0.7%	4.0%	3.9%
Metropolitan Atlanta	0.2%	0.2%	5.2%	5.1%
Statistical Test	X <sup>2</sup> =19948.3 df=16		P<0.05	
Marital Status				
Single	11.2%	4.6%	7.6%	7.6%
Married	60.6%	69.4%	59.7%	59.8%
Separated/divorced/widowed	26.9%	23.6%	30.6%	30.6%
Unknown	1.2%	2.4%	2.1%	2.1%
Statistical Test	X <sup>2</sup> =59.2 df=6		P<0.05	

Footnote: 1. Total includes cancer cases for all three study groups.

**Table 4.22 Distribution of prognostic factors in lung cancer cases for each study groups, SEER, 1973-92.**

Lung Cancer	Second generation Chinese	First generation Chinese	US born white	Total <sup>1</sup>
Number of cases	467	1221	130960	132648
SEX				
Male	63.6%	64.7%	66.8%	66.8%
Female	36.4%	35.3%	33.2%	33.2%
Statistical Test	$X^2=4.6$	df=2	P=0.10	
Age at diagnosis				
0-44	4.3%	2.9%	3.1%	3.1%
45-64	40.9%	32.7%	44.2%	44.1%
65-74	34.5%	36.5%	35.2%	35.2%
>74	20.3%	27.9%	17.5%	17.6%
Statistical Test	$X^2=116.9$	df=6	P<0.05	
Stage at diagnosis				
Localized	18.8%	17.9%	19.8%	19.7%
Regional	32.3%	28.3%	31.4%	31.4%
Distant	48.8%	53.7%	48.8%	48.8%
Statistical Test	$X^2=12.1$	df=4	P<0.05	
Year of diagnosis				
1973-1982	45.2%	37.5%	44.2%	44.1%
1983-1992	54.8%	62.5%	55.8%	55.9%
Statistical Test	$X^2=21.9$	df=2	P<0.05	
Directed Surgery				
No directed surgery	64.7%	79.0%	73.3%	73.3%
Directed surgery	35.3%	21.0%	26.7%	26.7%
Statistical Test	$X^2=37.7$	df=2	P<0.05	
SEER Registries				
San Francisco-Oakland	35.3%	81.7%	14.2%	14.9%
Connecticut	0.2%	1.0%	18.7%	18.5%
Metropolitan Detroit	0.4%	1.6%	19.2%	19.0%
Hawaii	61.7%	7.5%	1.4%	1.6%
Iowa	0.0%	0.1%	17.9%	17.6%
New Mexico	0.4%	0.4%	5.2%	5.1%
Seattle(Puget Sound)	1.9%	6.3%	13.8%	13.7%
Utah	0.0%	0.5%	2.8%	2.7%
Metropolitan Atlanta	0.0%	1.0%	6.9%	6.8%
Statistical Test	$X^2=15601.5$	df=16	P<0.05	
Marital Status				
Single	11.6%	4.3%	6.4%	6.4%
Married	66.4%	68.1%	66.0%	66.0%
Separated/divorced/widowed	20.3%	25.3%	25.6%	25.5%
Unknown	1.7%	2.3%	2.0%	2.0%
Statistical Test	$X^2=33.8$	df=6	P<0.05	

Footnote: 1. Total includes cancer cases for all three study groups.

In contrast to the prostate cancer patients, about 50% of the other cancer patients were diagnosed in each period. San Francisco-Oakland, Connecticut state, Metropolitan Detroit, Iowa, and Seattle(Puget Sound) cancer registries included about 12% to 22% patients of each kind of cancer. Other cancer registries included less than 10% patients of each kind of cancer.

Comparisons of the difference among the three study groups within each cancer site are as follows. First, the first generation Chinese breast cancer patients have a higher percentage diagnosed before age 45 (24%) than the other study groups (12-16%). The second generation Chinese immigrants have a higher percentage of localized stage breast cancer at diagnosis (60%) than other study groups (51-56%). About 78% first generation Chinese female breast cancer patients came from San Francisco-Oakland registry, while 62% second generation Chinese female breast cancer patients came from Hawaii registry. Second generation Chinese female breast cancer patients had a slightly higher percentage of single marital status (14.2%) than other two study groups (6.1% and 8.3%) (Table 4.19). Second, the first generation Chinese prostate cancer patients have a higher percentage diagnosed after age 74 (55%) than the other study groups (38-39%). The second generation Chinese prostate cancer patients have slightly higher percentage of not having directed surgery during the first course of therapy (40%) than other study groups (29-32%). Both Chinese immigrant groups had higher proportion of prostate cancer patients (73% and 72%) diagnosed between 1983-92 compared to US born white Americans (59%). 78% of first generation Chinese prostate cancer patients came from San Francisco-Oakland registry, while 77% second generation

Chinese prostate cancer patients came from Hawaii registry (Table 4.20). Third, the second generation Chinese immigrants have a higher percentage of localized stage colon & rectum cancer at diagnosis (40%) than other study groups (34-34%), and they also have a higher percentage of having directed surgery during the first course of therapy (93%) than other study groups (90-91%). 79% of first generation Chinese colon & rectum cancer patients came from San Francisco-Oakland registry, while 68% second generation Chinese colon & rectum cancer patients came from Hawaii registry (Table 4.21). Fourth, the second generation Chinese lung cancer patients have a higher percentage diagnosed before age 45(4.3%) than other study groups (2.9-3.1%), and they also have a higher percentage having directed surgery during the first course of therapy (35%) than other study groups (21-27%). 82% of first generation Chinese lung cancer patients came from San Francisco-Oakland registry, while 62% second generation Chinese lung cancer patients came from Hawaii registry (Table 4.22). US born white cancer patients came from each SEER registry and the proportions of cases were related to the size of population, which each SEER registry covered.

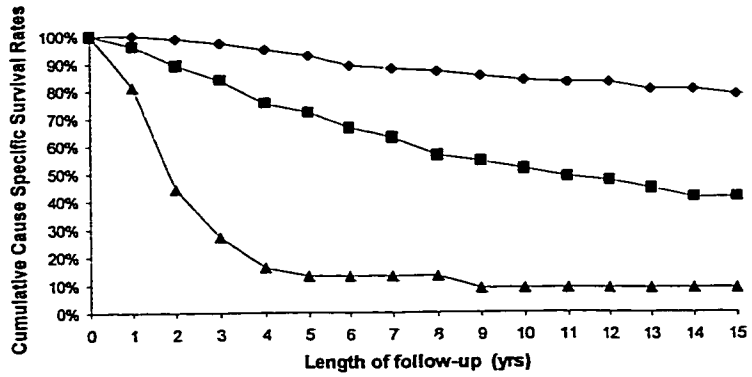
#### **4.8.2 Comparisons of observed, relative, and cause-specific survival rates for selected cancer sites within each study group:**

To compare the difference among the observed, relative, and cause-specific survival rates, three survival rates were computed and compared within the same study group for the same selected cancer site. Overall, the observed, relative, and cause-specific survival rates for female breast cancer and prostate cancer are better than for male or female colon &

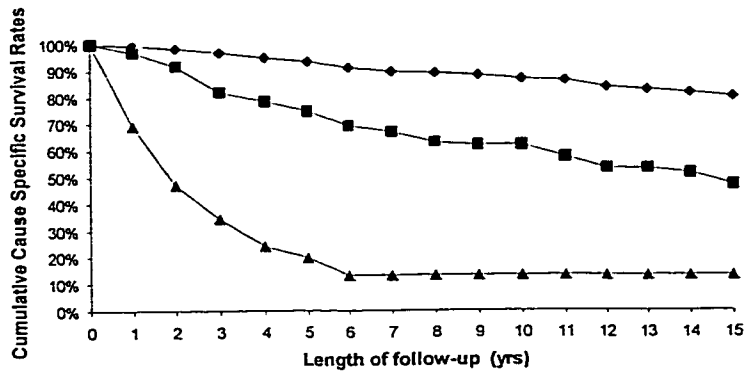
rectum cancer. And the survival rates for male or female lung cancer patients are the worst. Stage at diagnosis was strongly associated with cancer survival. Patients diagnosed at localized stage had the highest survival rates for each selected cancer, while patients diagnosed at distant stage had the lowest survival rates. Figures 4.5-4.7 show the stage effects for female breast cancer in three study groups by using cause specific survival rate. The stage effects existed in each study group. The stage effects also were found by using relative and observed survival rates and for each cancer. These similar analysis have been done among each study group for each selected cancer site (the results and graphs not included in thesis).

Figures 4.8-4.13 show the comparisons of three survival rates for the six selected cancer sites in second generation Chinese immigrants. Figures 4.14-4.19 show the comparisons of three survival rates for the six selected cancer sites in first generation Chinese immigrants. Figure 4.20-4.25 show the same comparisons as above in the US born white Americans . There are some quite similar findings among these figures. First, the relative survival and cause specific survival rates are very close and they are better than observed survival rate. Second, the differences between relative or cause specific survival rate and observed survival rate are more obvious in prostate and breast cancer than lung cancer. Third, the order of the three survival curves are consistent for each cancer site among every study group (i.e., the cause specific survival curve at the top, the relative survival curve in the middle and the observed survival curve at the bottom). Few overlaps of relative and cause specific survival rates are found in first or second generation Chinese immigrants and

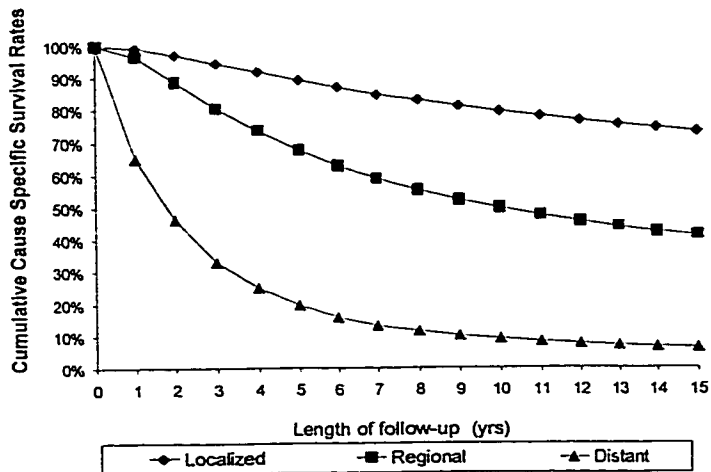
**Fig.4.5 Female breast cancer survival by stages in first generation Chinese immigrants, SEER 1973-92**



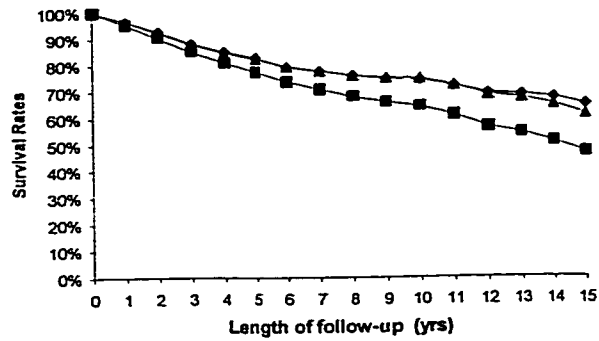
**Fig.4.6 Female breast cancer survival by stages in second generation Chinese immigrants, SEER 1973-92**



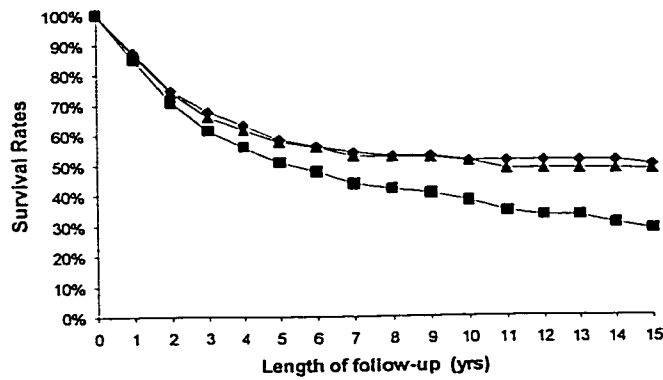
**Fig. 4.7 Female breast cancer survival by stage in US born white Americans, SEER 1973-92**



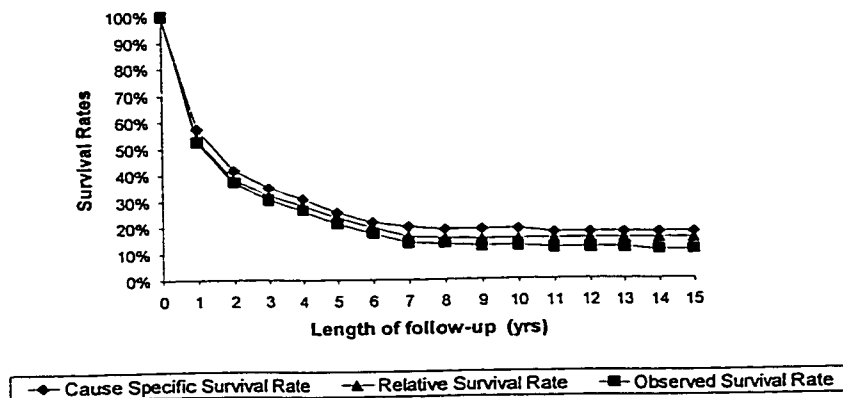
**Fig. 4.8 Comparison of three survival rates for female breast cancer in second generation Chinese immigrants, SEER 1973-92**



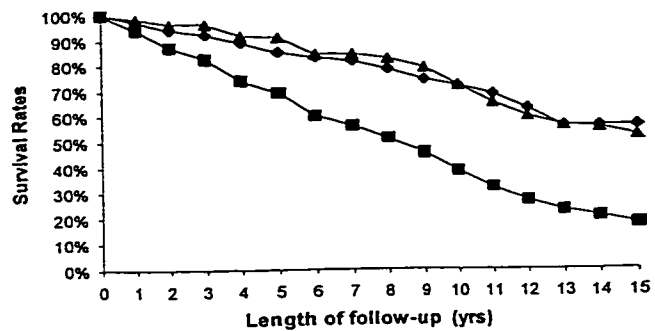
**Fig 4.9 Comparison of three survival rates for female colon & rectum cancer in second generation Chinese immigrants, SEER 1973-92**



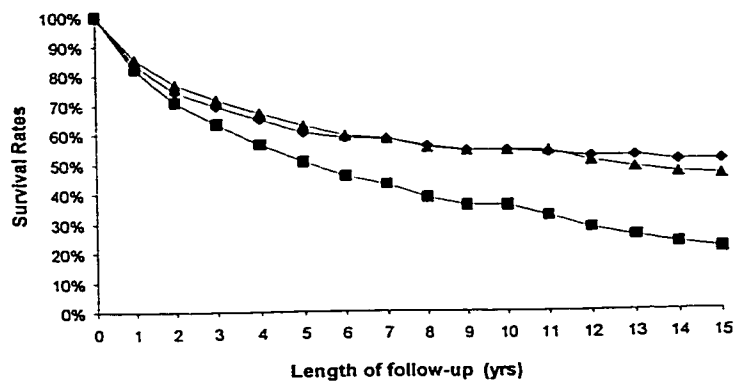
**Fig 4.10 Comparison of three survival rates for female lung cancer in second generation Chinese immigrants, SEER 1973-92**



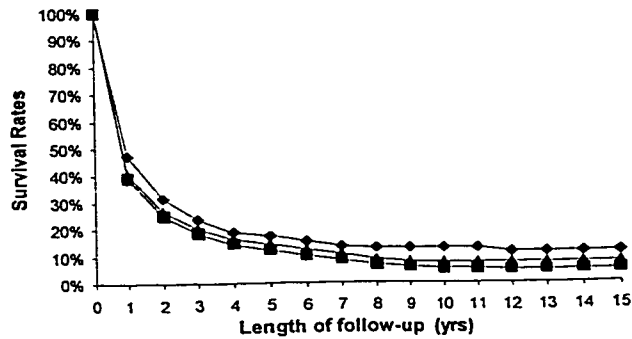
**Fig. 4.11 Comparison of three survival rates for prostate cancer in second generation Chinese immigrants, SEER 1973-92**



**Fig. 4.12 Comparison of three survival rates for male colon & rectum cancer in second generation Chinese immigrants, SEER 1973-92**

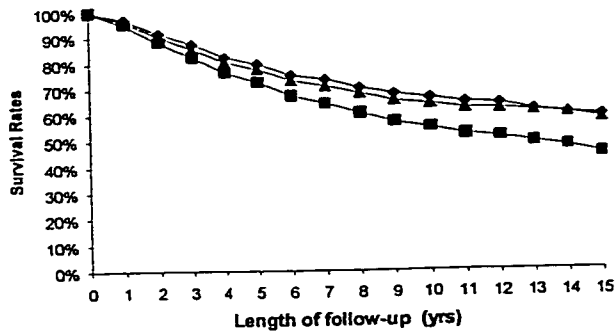


**Fig 4.13 Comparison of three survival rates for male lung cancer in second generation Chinese immigrants, SEER 1973-92**

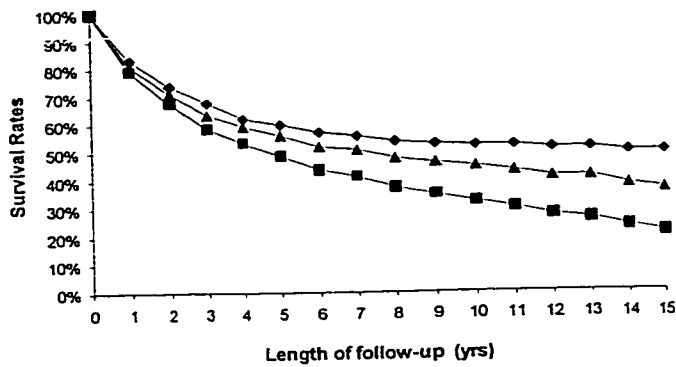


◆ Cause Specific Survival Rate    ▲ Relative Survival Rate    ■ Observed Survival Rate

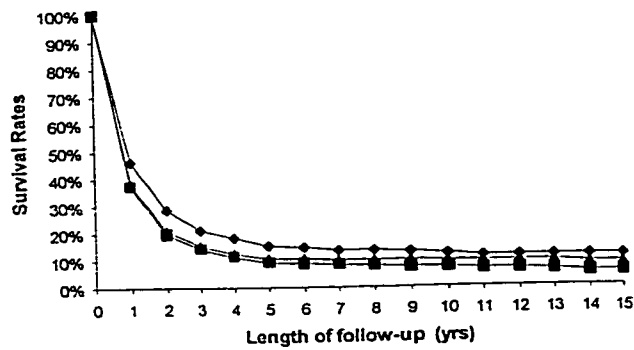
**Fig 4.14 Comparison of three survival rates for female breast cancer in first generation Chinese immigrants, SEER 1973-92**



**Fig 4.15 Comparison of three survival rates for female colon & rectum cancer in first generation Chinese immigrants, SEER 1973-92**

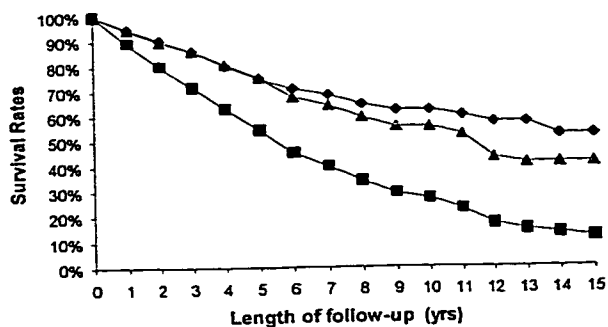


**Fig 4.16 Comparison of three survival rates for female lung cancer in first generation Chinese immigrants, SEER 1973-92**

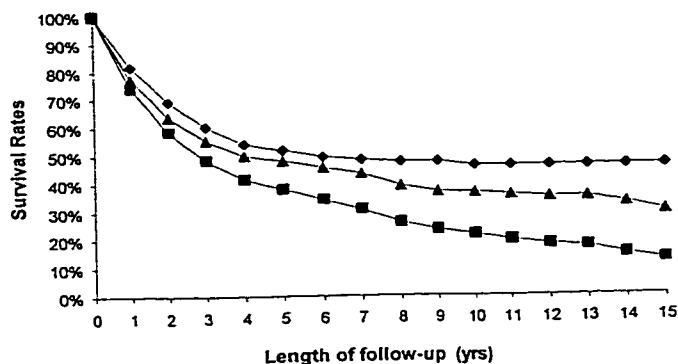


◆ Cause Specific Survival Rate    ▲ Relative Survival Rate    ■ Observed Survival Rate

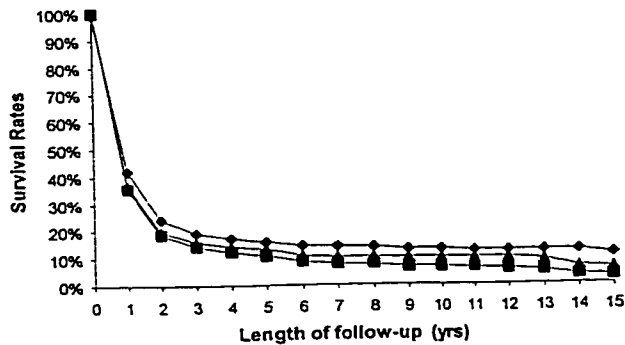
**Fig 4.17 Comparison of three survival rates for prostate cancer in first generation Chinese immigrants, SEER 1973-92**



**Fig. 4.18 Comparison of three survival rates for male colon & rectum cancer in first generation Chinese immigrants, SEER 1973-92**

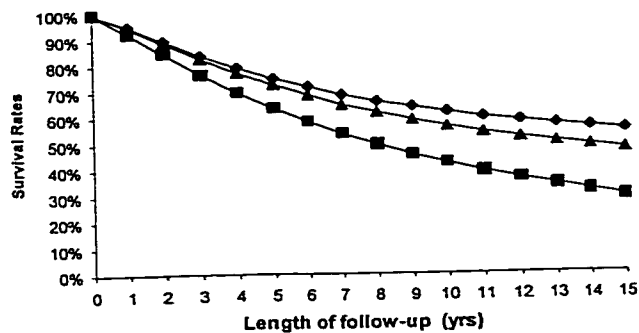


**Fig 4.19 Comparison of three survival rates for male lung cancer in first generation Chinese immigrants, SEER 1973-92**

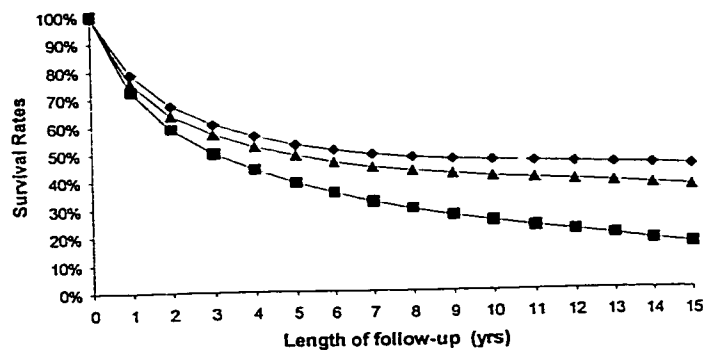


—●— Cause Specific Survival Rate    —▲— Relative Survival Rate    —■— Observed Survival Rate

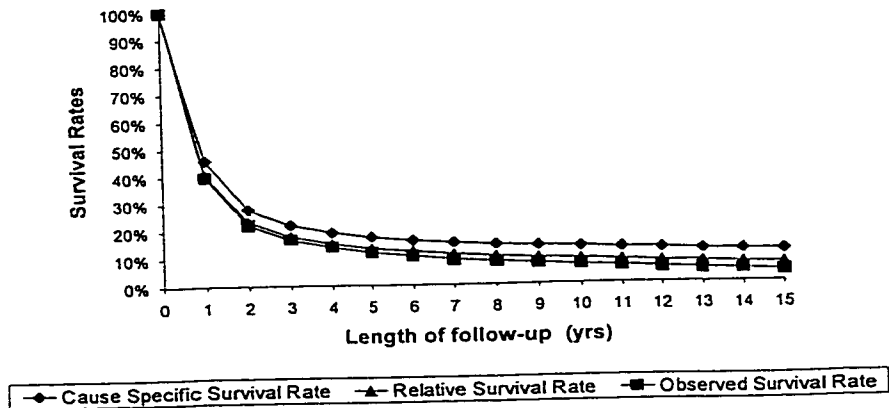
**Fig 4.20 Comparison of three survival rates for female breast cancer in US born white Americans, SEER 1973-92**



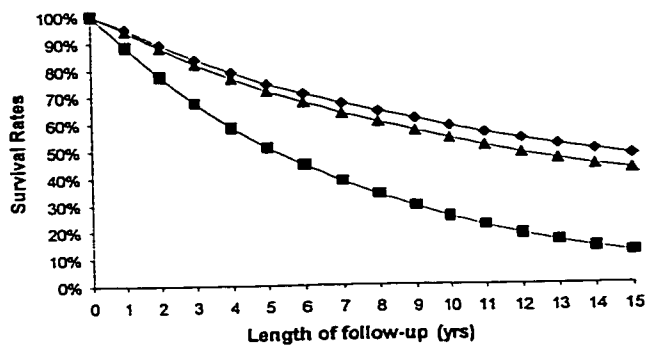
**Fig 4.21 Comparison of three survival rates for female colon & rectum cancer in US born white Americans, SEER 1973-92**



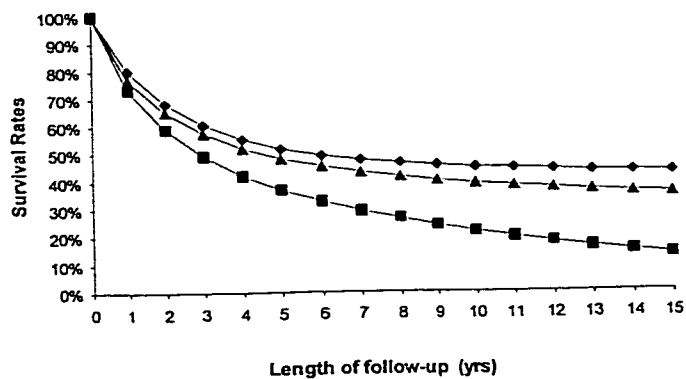
**Fig 4.22 Comparison of three survival rates for female lung cancer in US born white Americans, SEER 1973-92**



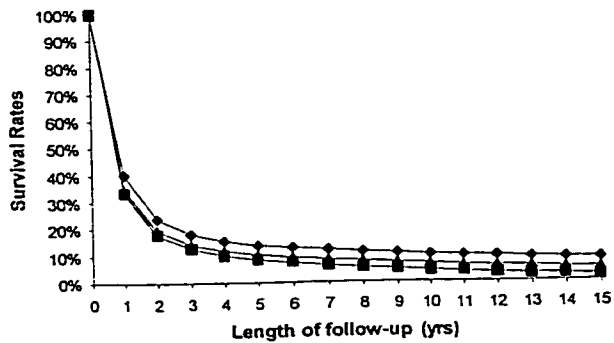
**Fig 4.23 Comparison of three survival rates for prostate cancer in US born white Americans, SEER 1973-92**



**Fig. 4.24 Comparison of three survival rates for male colon & rectum cancer in US born white Americans, SEER 1973-92**



**Fig 4.25 Comparison of three survival rates for male lung cancer in US born white Americans, SEER 1973-92**



—◆— Cause Specific Survival Rate    —▲— Relative Survival Rate    —■— Observed Survival Rate

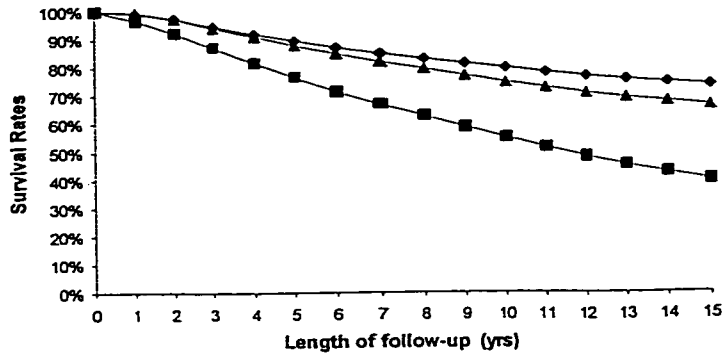
then mainly after more than ten years of follow-up. Since these two groups have relatively small population, especially after ten years of follow-up, the survival curves become unstable.

Figures 4.26-4.28 show the comparisons among cause specific, relative and observed survival rates of one selected cancer site in same study group and same diagnosis stage. The biggest difference between cause specific or relative and observation is in localized stage. At distant stage the survival rates become lower and the difference between cause specific or relative and observed survival rates become smaller. The differences between the three measures were largest when the proportion of deaths from other causes was large, for example, in cancers with high survival (localized stage cancers or breast and prostate cancers etc.), among older patients, and for longer follow up times.

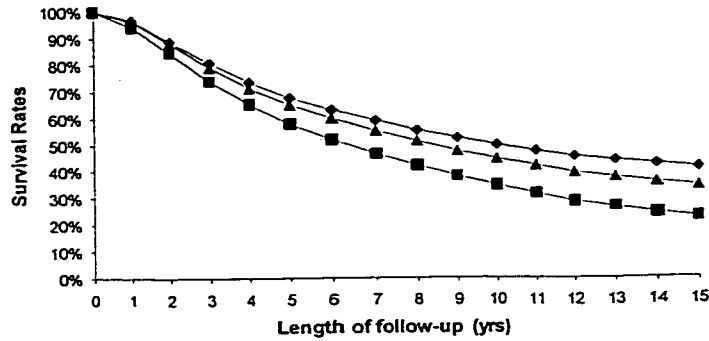
#### **4.8.3 Comparisons of cause-specific survival rates for selected cancer sites for the three study groups:**

The main propose of this study was to compare the survival pattern among three study groups. First we compared the cause-specific, relative and observed survival rates of each selected cancer site among the three study groups. For example, the cause-specific survival, the relative survival and observed survival rates of female breast cancer were compared separately among the three study groups ( Figures 4.29-4.31). There is a consistent finding from these three figures: the second generation Chinese immigrants have better survival for female breast cancer than the other study groups in all three kinds of survival rates. Similar comparisons were done for prostate ( Figures 4.32- 4.34), male colon & rectum

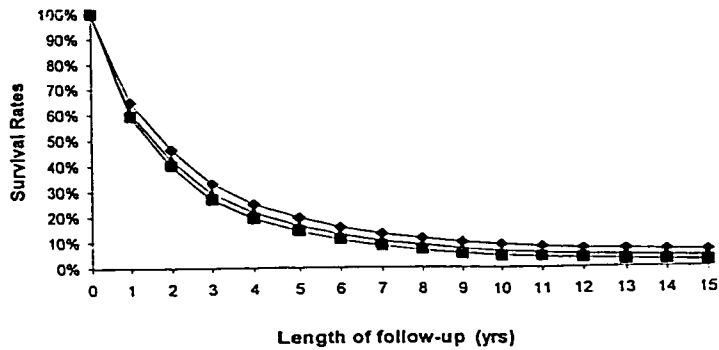
**Fig. 4.26 Comparison of three survival rates for female breast cancer (localized stage) in US born white Americans, SEER 1973-92**



**Fig. 4.27 Comparison of three survival rates for female breast cancer (Regional stage) in US born white Americans, SEER 1973-92**

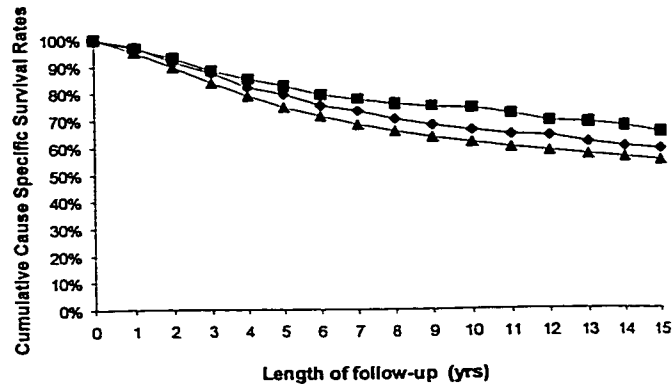


**Fig. 4.28 Comparison of three survival rates for female breast cancer (Distant stage) in US born white Americans, SEER 1973-92**

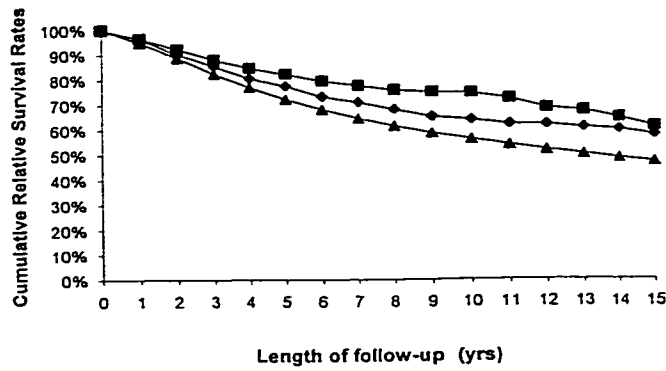


◆ Cause specific survival rates    ▲ Relative survival rates    ■ Observed survival rates

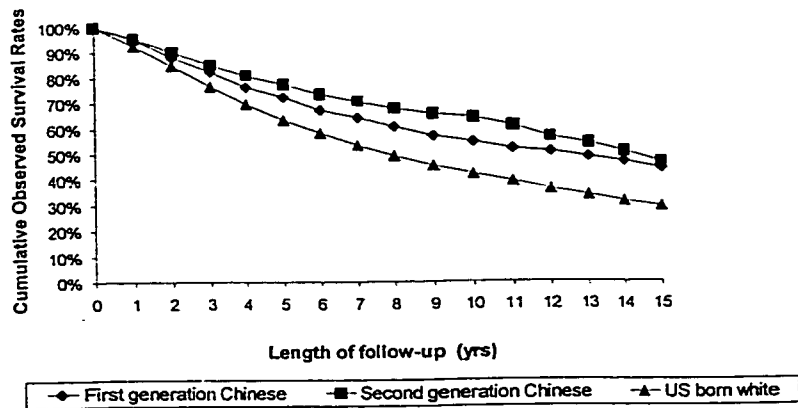
**Fig. 4.29 Female breast cancer specific survival rates in three study groups, SEER 1973-92**



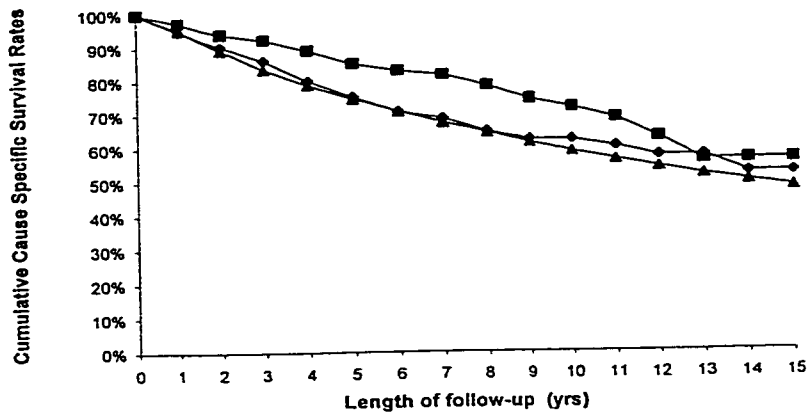
**Fig. 4.30 Female breast cancer relative survival rates in three study groups, SEER 1973-92**



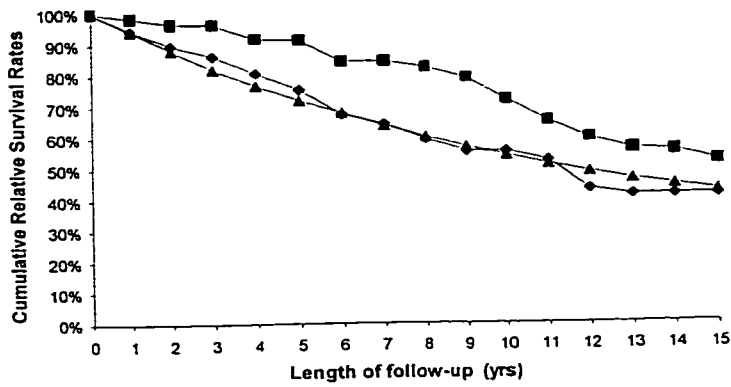
**Fig. 4.31 Female breast cancer observed survival rates in three study groups, SEER 1973-92**



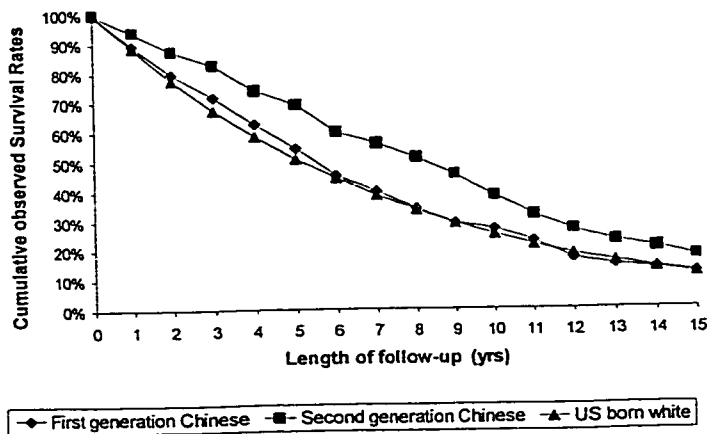
**Fig 4.32 Prostate cancer specific survival rates in three study groups, SEER 1973-92**



**Fig 4.33 Prostate cancer relative survival rates in three study groups, SEER 1973-92**



**Fig 4.34 Prostate cancer observed survival rates in three study groups, SEER 1973-92**

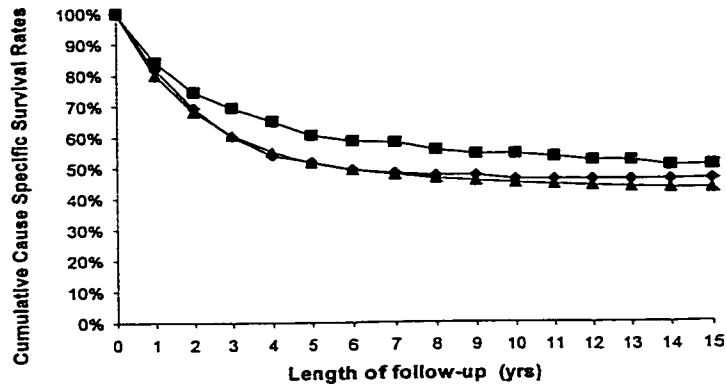


(Figures 4.35-4.37), female colon & rectum (Figures 4.38-4.40), male lung (Figures 4.41, -4.43) and female lung (Figures 4.44-4.46) cancers. The second generation Chinese immigrants have better survival for all three kinds of survival rates for prostate, male colon & rectum and female lung cancers. For female colon & rectum cancer, the second generation Chinese immigrants show higher relative and observed survival rates than other study groups. But there are lots of overlaps of cause specific survival rates between first and second generation Chinese immigrants. The three kinds of survival rates of male lung cancers for three study groups are all very close and hard to distinguish from each other. These results may be relevant to the higher percentage of localized stage at diagnosis in female breast, colon & rectum and lung cancers among second generation Chinese immigrants. Also the second generation Chinese immigrants had a higher percentage of having directed surgery during the first course of therapy for female breast, colon & rectum and lung cancer. Therefore, a Cox regression analysis was performed to adjust to the effect of stage. The differences between three measures were smallest when the proportion of deaths from other causes was small, for example, in cancers with low survival (distant stage cancers and lung cancer).

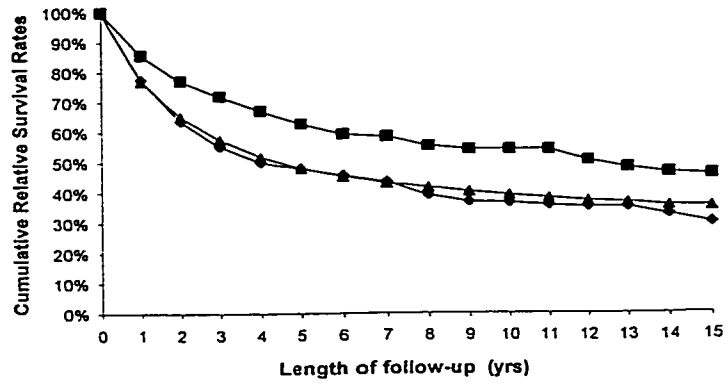
#### **4.8.4 Cox analysis:**

Multivariate survival analysis was conducted using a proportional hazard model proposed by Cox. Independent variables in the Cox proportional hazards model included: the three study groups, gender( expect for the breast and prostate cancer models), age at diagnosis, stage at diagnosis, had or did not have direct surgery, cancer registry, marital

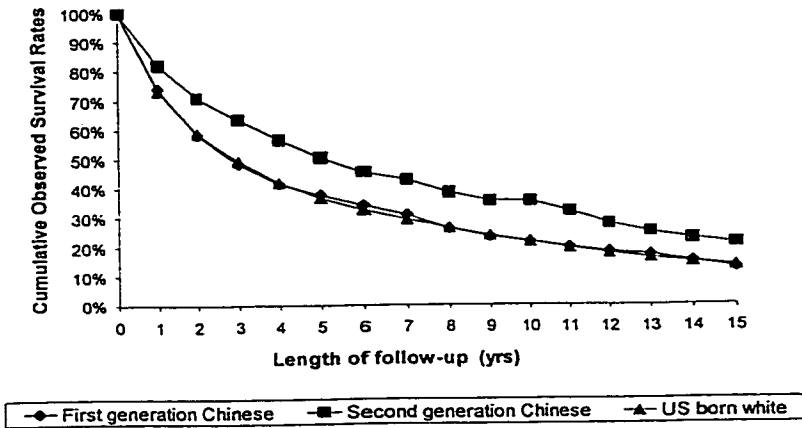
**Fig. 4.35 Male colon & rectum cancer specific survival rates in three study groups, SEER 1973-92**



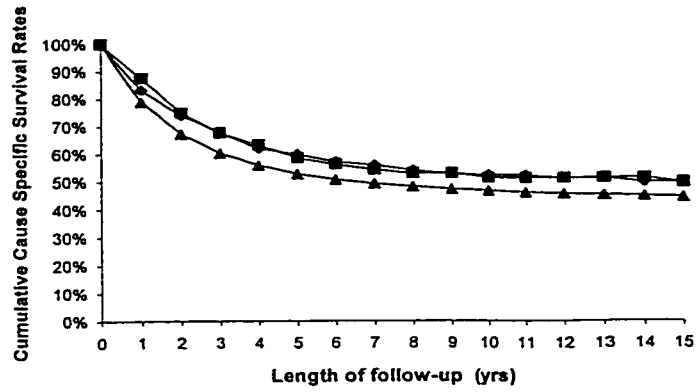
**Fig. 4.36 Male colon & rectum cancer relative survival rates in three study groups, SEER 1973-92**



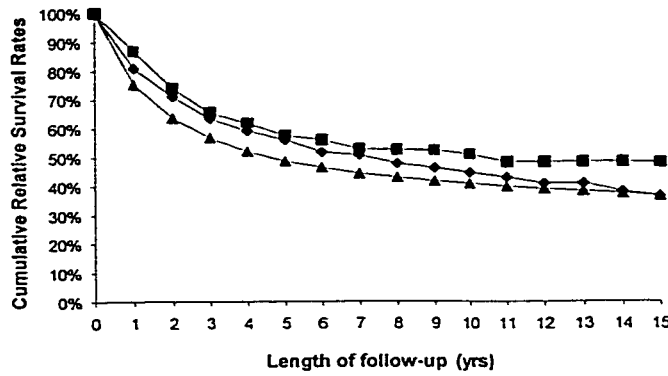
**Fig. 4.37 Male colon & rectum cancer observed survival rates in three study groups, SEER 1973-92**



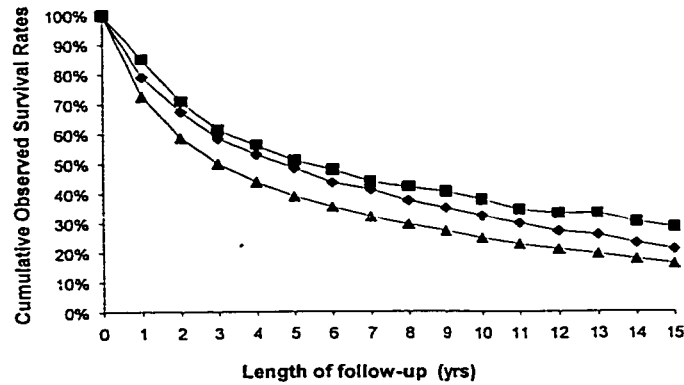
**Fig. 4.38 Female colon & rectum cancer specific survival rates in three study groups, SEER 1973-92**



**Fig. 4.39 Female colon & rectum cancer relative survival rates in three study groups, SEER 1973-92**

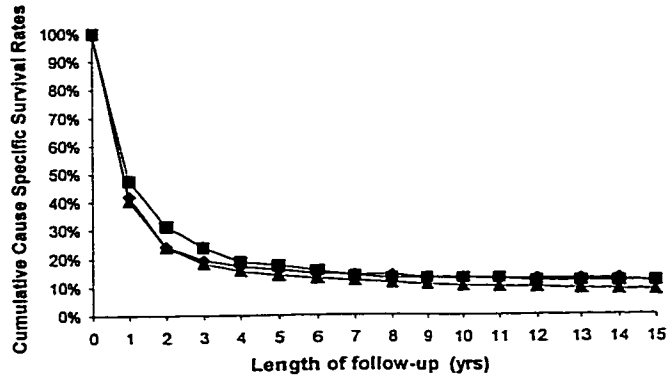


**Fig. 4.40 Female colon & rectum cancer observed survival rates in three study groups, SEER 1973-92**

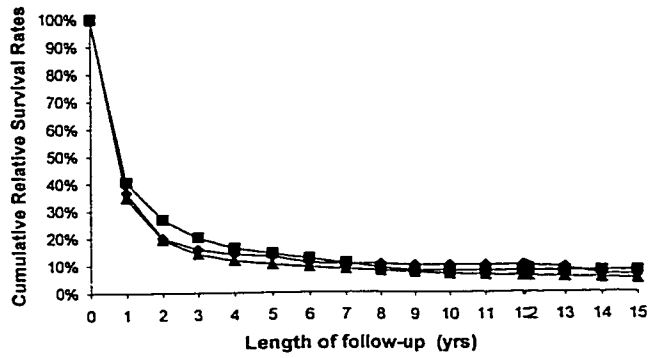


◆ First generation Chinese    ■ Second generation Chinese    ▲ US born white

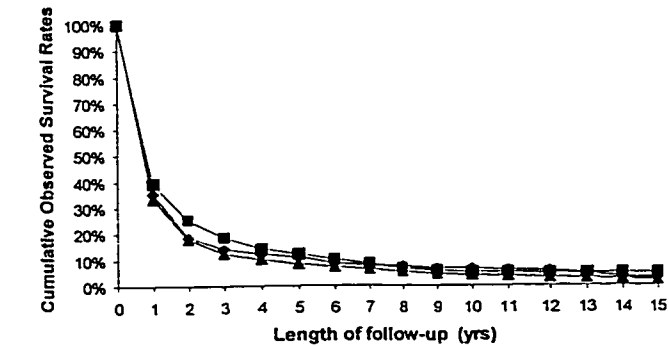
**Fig. 4.41 Male lung cancer specific survival rates in three study groups, SEER 1973-92**



**Fig. 4.42 Male lung cancer relative survival rates in three study groups, SEER 1973-92**

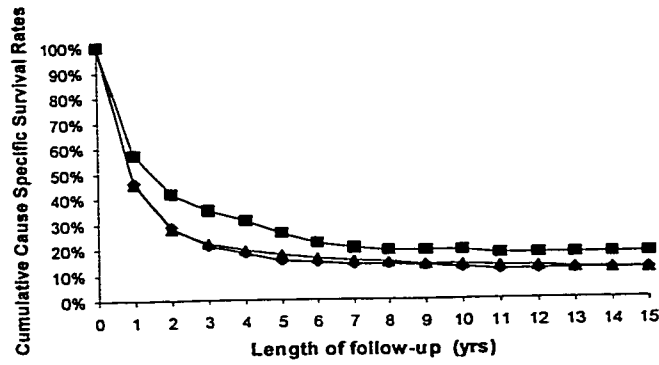


**Fig 4.43 Male lung cancer observed survival rates in three study groups, SEER 1973-92**

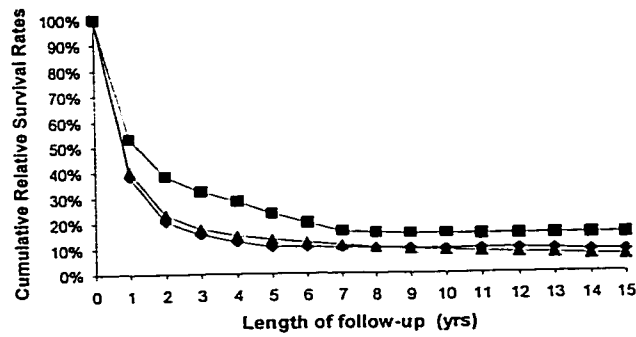


◆ First generation Chinese    ■ Second generation Chinese    ▲ US born white

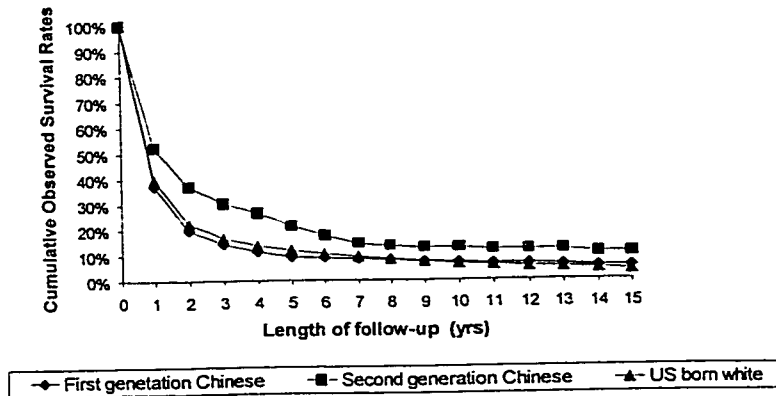
**Fig. 4.44 Female lung cancer specific survival rates in three study groups, SEER 1973-92**



**Fig. 4.45 Female lung cancer relative survival rates in three study groups, SEER 1973-92**



**Fig. 4.46 Female lung cancer observed survival rates in three study groups, SEER 1973-92**



status and period of diagnosis. The regression analysis were conducted separately for the different cancer sites: female breast cancer, prostate cancer, colon & rectum cancer and lung cancer.

There were 114,804 female breast cancer, 84,679 prostate cancer, 56,507 male and 54,730 female colon & rectum cancer, and 82,983 male and 41,491 female lung cancer cases available for multivariate survival analyses in each cancer site.

The reference group for stage was localized stage; second generation Chinese immigrant was the reference group for study groups. The youngest age group (0-44 years old) was treated as a reference group for other age groups. The survival rates for cancer patients with directed surgery after cancer diagnosis were set as the baseline and were compared to the survival rates for patients without directed surgery. The San Francisco-Oakland Registries was the reference group for the comparison among nine SEER registries.

The assumptions of proportional hazard for each prognostic factor for each selected cancer site were tested by using log(-log) graphical method <sup>[62]</sup>. The parallel curves indicated that the proportional hazard assumption for each prognostic factor being studied was satisfied (The graphs were not included but available from the author on request).

Table 4.23-4.26 showed the results of multivariate survival analyses for each selected cancer site. Generally speaking, being a second generation Chinese immigrant led to better survival than being a US born white American in each cancer sites. After adjusting for all prognostic factors, the second generation Chinese immigrants had better survival than the US

**Table 4.23 Multivariate survival analyses of patients with female breast cancer in three study groups, SEER 1973-92.**

Prognostic Factors		Number	Exp.(B)	95%CI	
<b>Sex</b>					
	Male	N/A	N/A	N/A	N/A
	Female	114804	N/A	N/A	N/A
<b>Study groups</b>					
	Second generation Chinese	542	1.00	-	-
	First generation Chinese	610	0.85	0.68	1.07
	US born white	113652	0.86	0.73	1.03
<b>Age at diagnosis</b>					
	0-44	14582	1.00	-	-
	45-64	48177	0.87	0.85	0.90
	65-74	27793	0.77	0.74	0.80
	75+	24252	0.80	0.77	0.83
<b>Stage at diagnosis</b>					
	Localized	58849	1.00		
	Regional	46552	2.99	2.92	3.06
	Distant	9403	10.63	10.28	11.00
<b>Treatment</b>					
	Directed surgery	108775	1.00	-	-
	No directed surgery	6029	2.11	2.04	2.20
<b>Year of diagnosis</b>					
	1973-1982	55338	1.00	-	-
	1983-1992	59466	1.09	1.07	1.11
<b>SEER registries</b>					
	San Francisco-Oakland	18596	1.00	-	-
	Connecticut	25061	1.07	1.04	1.11
	Metropolitan Detroit	16362	1.56	1.50	1.61
	Hawaii	2129	0.64	0.57	0.71
	Iowa	16893	1.57	1.51	1.63
	New Mexico	5737	1.34	1.28	1.41
	Seattle(Puget Sound)	17461	0.94	0.90	0.97
	Utah	4729	1.56	1.48	1.64
	Metropolitan Atlanta	7836	1.01	0.96	1.06
<b>Marital Status</b>					
	Single	9494	1.00	-	-
	Married	65162	0.91	0.88	0.95
	Separated/Divorced/Widowed	38007	0.97	0.93	1.01
	Unknown Status	2141	0.89	0.82	0.97

**Table 4.24 Multivariate survival analyses of patients with prostate cancer in three study groups, SEER 1973-92.**

Prognostic Factors		Number	Exp.(B)	95%CI	
Sex					
	Male	84679	N/A	N/A	N/A
	Female	N/A	N/A	N/A	N/A
Study groups					
	Second generation Chinese	344	1.00	-	-
	First generation Chinese	360	1.24	0.90	1.71
	US born white	83975	1.39	1.08	1.79
Age at diagnosis					
	0-44	103	1.00	-	-
	45-64	16306	0.76	0.58	1.01
	65-74	35159	0.83	0.63	1.09
	75+	33111	1.07	0.81	1.42
Stage at diagnosis					
	Localized	53689	1.00	-	-
	Regional	14621	2.14	2.06	2.22
	Distant	16369	7.26	7.05	7.47
Treatment					
	Directed surgery	58145	1.00	-	-
	No directed surgery	26534	1.29	1.25	1.32
Year of diagnosis					
	1973-1982	34200	1.00	-	-
	1983-1992	50479	0.90	0.87	0.92
SEER registries					
	San Francisco-Oakland	11423	1.00	-	-
	Connecticut	13045	1.10	1.05	1.15
	Metropolitan Detroit	10475	1.41	1.34	1.48
	Hawaii	1661	0.72	0.64	0.81
	Iowa	15731	1.25	1.19	1.30
	New Mexico	6335	1.13	1.06	1.20
	Seattle(Puget Sound)	15500	0.75	0.71	0.79
	Utah	5628	1.10	1.04	1.17
	Metropolitan Atlanta	4881	0.96	0.90	1.02
Marital Status					
	Single	4795	1.00	-	-
	Married	64340	0.86	0.81	0.90
	Separated/Divorced/Widowed	13407	1.02	0.96	1.08
	Unknown Status	2137	0.86	0.78	0.94

**Table 4.25 Multivariate survival analyses of patients with colon & rectum cancer in three study groups, SEER 1973-92.**

Prognostic Factor		Number	Exp.(B)	95%CI	
<b>Sex</b>					
	Male	56507	1.00	-	-
	Female	54730	0.95	0.93	0.96
<b>Study groups</b>					
	Second generation Chinese	548	1.00	-	-
	First generation Chinese	999	1.01	0.86	1.20
	US born white	109690	1.03	0.89	1.18
<b>Age at diagnosis</b>					
	0-44	3351	1.00	-	-
	45-64	33293	1.03	0.98	1.08
	65-74	36576	1.06	1.01	1.12
	75+	38017	1.20	1.15	1.27
<b>Stage at diagnosis</b>					
	Localized	38593	1.00	-	-
	Regional	45788	3.15	3.07	3.23
	Distant	26856	13.33	12.96	13.72
<b>Treatment</b>					
	Directed surgery	101474	1.00	-	-
	No directed surgery	9763	2.57	2.50	2.64
<b>Year of diagnosis</b>					
	1973-1982	53757	1.00	-	-
	1983-1992	57480	1.02	1.00	1.04
<b>SEER registries</b>					
	San Francisco-Oakland	15986	1.00	-	-
	Connecticut	24527	0.99	0.96	1.02
	Metropolitan Detroit	16876	1.13	1.09	1.17
	Hawaii	1846	0.83	0.77	0.91
	Iowa	22123	1.26	1.22	1.30
	New Mexico	5037	1.30	1.24	1.36
	Seattle(Puget Sound)	14781	0.90	0.87	0.93
	Utah	4340	1.31	1.25	1.38
	Metropolitan Atlanta	5721	0.89	0.85	0.93
<b>Marital Status</b>					
	Single	8355	1.00	-	-
	Married	66995	0.91	0.88	0.94
	Separated/Divorced/Widowed	33607	0.96	0.92	0.99
	Unknown Status	2280	0.87	0.81	0.94

**Table 4.26 Multivariate survival analyses of patients with lung cancer in three study groups, SEER 1973-92.**

Prognostic Factors		Number	Exp.(B)	95%CI	
Sex					
	Male	82983	1.00	-	-
	Female	41491	0.85	0.84	0.86
Study groups					
	Second generation Chinese	450	1.00	-	-
	First generation Chinese	1169	1.03	0.91	1.17
	US born white	122855	1.12	1.01	1.26
Age at diagnosis					
	0-44	3971	1.00	-	-
	45-64	56020	1.11	1.07	1.15
	65-74	43687	1.28	1.23	1.32
	75+	20796	1.48	1.42	1.54
Stage at diagnosis					
	Localized	25373	1.00	-	-
	Regional	39965	1.74	1.70	1.77
	Distant	59136	3.09	3.03	3.16
Treatment					
	Directed surgery	34741	1.00	-	-
	No directed surgery	89733	2.48	2.43	2.52
Year of diagnosis					
	1973-1982	54922	1.00	-	-
	1983-1992	69552	0.92	0.91	0.93
SEER registries					
	San Francisco-Oakland	18608	1.00	-	-
	Connecticut	23289	1.00	0.98	1.02
	Metropolitan Detroit	23604	1.11	1.09	1.14
	Hawaii	2067	0.95	0.90	1.00
	Iowa	21743	1.1	1.08	1.12
	New Mexico	6284	1.14	1.11	1.18
	Seattle(Puget Sound)	17089	0.99	0.97	1.02
	Utah	3293	1.12	1.08	1.17
	Metropolitan Atlanta	8497	0.99	0.96	1.02
Marital Status					
	Single	7803	1.00	-	-
	Married	82952	0.93	0.91	0.96
	Separated/Divorced/Widowed	31231	0.99	0.96	1.02
	Unknown Status	2488	0.89	0.84	0.93

born white Americans in prostate and lung cancers. There are no difference in survival between the three study groups in female breast and colon & rectum cancers after adjusting other risk factors. Table 4.27 presents the comparisons of relative risk for dying from selected cancer between second generation Chinese immigrants and US born white Americans, first generation Chinese immigrants and US born white Americans, and second generation Chinese immigrants and first generation Chinese immigrants. These comparisons were conducted after adjusting for other prognostic factors. The result indicated that the second generation Chinese immigrants had better survival in prostate and lung cancers than US born whites. The first generation Chinese immigrants had better survival in lung cancer than US born white Americans. There are no difference in term of survival between first and second generation Chinese immigrants.

A survival difference between genders was found in lung and colon & rectum cancers. Male patients had a lower survival experience than female patients in these cancer sites. Stage had a very strong effect on cancer survival for each selected cancer site. Patients diagnosed at the localized stage had the best survival rates, while patients diagnosed at distant stage had the worst survival rates. Age at diagnosis had some impact on survival in some cancer. For example, female breast cancer patients in the youngest age group had the poorest survival rates among all age groups. For colon & rectum and lung cancer patients, survival was worse at older ages. There was no significant difference in survival rates among age groups for prostate cancer. Patients having had cancer directed surgery had better survival than patients who did not have cancer directed surgery for each selected cancer site.

**Table 4.27 Comparison of relative risk for dying from cancer among three study groups, SEER, 1973-92**

Sites	Second generation Chinese vs US born white Americans*		First generation Chinese vs US born white Americans*		Second generation Chinese vs first generation Chinese*		
	Exp(b)	95% CI	Exp(b)	95% CI	Exp(b)	95% CI	
Breast cancer	1.16	0.97	0.99	0.85	1.17	0.94	1.47
Prostate cancer	0.72	0.56	0.89	0.73	0.81	0.59	1.11
Colorectal cancer	0.97	0.84	0.98	0.89	0.99	0.84	1.17
Lung cancer	0.89	0.80	0.92	0.86	0.97	0.85	1.10

*Note\** Represent the reference group in each comparison.

Patients diagnosed before 1983 year had different survival rates in some cancer sites. For example, patients diagnosed in 1983-92 had better survival rates than those who diagnosed in 1973-82 for prostate and lung cancer; on the other hand, patients diagnosed in the early time period had better survival rates than those who diagnosed in later years for breast and colon & rectum cancers. Among nine SEER registries, Hawaii and Seattle registries had better survival rates than San Francisco-Oakland in most cancer sites, whereas other registries either had higher survival rates or no significant difference comparing to San Francisco-Oakland registry.

#### **4.8.5 Summary:**

There were some similarity in findings from survival analysis by using different survival rates. Generally speaking, the second generation Chinese immigrants had a better survival than US born whites in most selected cancer sites. Some of the explanations may be attributed to the higher percentage of localized stage cancers were diagnosed among this group, (e.g, the second generation Chinese immigrants had the highest percentage of localized stage at diagnosed for female breast, colon & rectum and lung cancers). Moreover, the percentage of people having directed surgery during the first course of therapy among second generation Chinese immigrants was higher, (i.e. they had a higher percentage of having directed surgery for colon & rectum and lung cancer). After adjusting for other prognostic factors, the second generation Chinese immigrants had better survival in prostate and lung cancers than US born whites. Besides the prognostic factors studied in this study, there are other factors which had effects on survival of each study groups. For example,

socioeconomic status and other clinical treatments information were not be available in this study because of the limitations of SEER data.

## **CHAPTER 5. DISCUSSION:**

### **5.1 General:**

In this study, the SEER data were used to compare cancer incidence and survival in the three study groups (first and second generation Chinese immigrants and US born white Americans). In general, second generation Chinese immigrants had incidence rates intermediate between first generation Chinese immigrants and US born white Americans. However, they retained high rates of nasopharynx and liver cancers in both males and females.

This study is the one of the first to examine survival for cancer at selected sites in first and second generation Chinese immigrants. The second generation Chinese immigrants had better survival rates for most selected cancer sites than the other study groups.

#### **5.1.1 Study design of this study:**

The studies of cancer incidence and survival pattern in the offspring of migrants are concerned with the concept of time as a measure of dose of environmental factors in disease causation. The offspring of migrants are, of course, exposed to the environment of the host country throughout their entire life (although they may retain some of the lifestyle of their parents). Study of their cancer incidence and survival patterns in relation to those in the first generation, in their country of origin, and in the local born, provides additional information on the relative importance of environmental and genetic factors in etiology. This study took advantage of SEER data, which collects information on the demographic characteristics of

the patient (including place of birth and race/ethnicity), anatomic site of the malignancy, histologic cell type, extent (stage) of the disease at time of diagnosis, treatment, and follow-up, including survival status and cause of death. The combination of ethnicity and birthplace was used to separate first generation and second generation Chinese immigrants and to define the US born white Americans. Comparisons of incidence and survival rates were conducted among first generation Chinese immigrants, second generation Chinese immigrants and US born white Americans.

This study did not compare the incidence and survival rate of Chinese migrants to the rates of population in China (country of origin) for the following reasons:

First, it is well known that the rates of many cancers vary greatly among different geographic areas of China. Reviewing the history of Chinese migrating to the United States, we knew that from 1850s to 1882, Chinese immigrants mainly were from the Guangdong area in southern China and immigrated to the United States as laborers. After a prohibition period, limited numbers of Chinese were again permitted to enter the United States in 1943; and since 1968, larger numbers of Chinese came primarily from the educated classes outside mainland China. Since 1980, larger numbers of Chinese came from mainland China. Therefore, Chinese immigrants in the United States come from very different geographic area of China. Because no rates are available for each different geographic areas of China, (especially for Guangdong province) and no birthplace information was recorded at provincial level for Chinese immigrants, the comparison of rates between immigrants and their country of origin must be interpreted with caution. <sup>[35]</sup>.

Second, no national cancer incidence information is available for China<sup>[36]</sup>. However, some cancer incidence rates for parts of the Chinese population in China are available, (i.e. from Shanghai, Tianjin and Qidong – three big cities in mainland China)<sup>[37]</sup>. There are also no truly national cancer incidence rates for the United States. The SEER registries only cover nine geographic areas in United States. There are many environmental and socioeconomic difference between individual cities of the two countries. We would not be able to determine whether the difference in cancer incidence between Chinese migrants in the United States and Chinese in China was due to the physical environment or to socioeconomic effects. Moreover, survival rates for the Chinese population in China is not available. There are no internationally comparable data for survival between China and the United States.

Third, although in the past few years, special efforts have been made to improve international comparability among cancer registries<sup>[7]</sup>, the quality control practices are different from country to country. Data from the registries within same country will have less difference in quality than data from different countries. The incidence and survival data for the three study groups in this study all came from SEER Program in the United States. Therefore, the biases caused by data collection, such as different diagnosis criteria or lack of completeness for registration, would be expected to be similar for the three study groups.

### **5.1.2 Population Counts for Incidence Rates:**

In order to produce incidence rates, we need counts of both the cancer cases and the population at risk. The SEER Public-Use CD-ROM provides population data for the white and black racial groups from Census Bureau of US. However, the SEER CD-ROM did not

provide population data for the Chinese population, and there is no place of birth variable in their population count files. Therefore, an alternative source directly from US Census Bureau was used to estimate the population for first and second generation Chinese immigrants and US born white Americans. The data were accessed through the on-line data extraction system. The Integrated Public Use Microdata Series (IPUMS-98), created by the University of Minnesota in November 1997, consists of high-precision samples of the American population drawn from federal censuses. It includes nearly all the detail originally recorded by the census enumeration. As a result, it is possible to construct a great variety of tabulations from these files. The population counts for first and second generation Chinese immigrants and US born white Americans were extracted by using both place of birth and race variables. Since the population counts for white and overall groups can be obtained from both SEER and IPUMS sources, the population counts of all white and overall groups in San Francisco, from 1970 to 1990 were compared between the two sources to estimate the accuracy of the on-line data extraction method. The results showed that the population counts from both sources were quite close and the errors were less than 1.4%. Therefore, the method we used to extract population counts for this study was acceptable. It is applicable to other migrant studies and other research which needs to calculate the population counts for specific racial groups.

### **5.1.3 The Net Survival Rates:**

This study not only compared the cancer incidence rates but also the survival rates among first and second Chinese immigrants and US born white Americans in the United

States. Three classical methods of survival rates were calculated and compared for selected cancer sites in each study group. The observed survival rate describes the likelihood of surviving all causes of death for a certain time after cancer diagnosis. The probability of survival should be considered as the result of two components, corresponding respectively to the cancer being studied and to all other causes taken together. The estimation of net survival probability responds to the need to make comparisons of cancer mortality among different populations in which mortality due to other causes may differ. There are two classical methods for calculating net survival rate: the method of cause-specific survival and that of relative survival<sup>[38]</sup>. Calculation of cause-specific survival rates only counts as deaths those patients who died from the cancer under study; those patients who died from other causes are treated as withdrawn from the study. This method needs data for the cause of each death. The method of relative survival does not require knowledge of the cause of death. To account for the risk of dying from other causes, the relative survival rate for particular groups of patients are computed by dividing the observed survival rates by expected (normal) survival rates for the subgroup of the general population with the same gender, race, and age characteristics as the patients subgroup<sup>[39]</sup>. The SEER data were linked to analytic packages in which relative survival rates were produced using built-in life tables (which provided expected survival rate for the general population in the United States by race, age and sex).

Since SEER registries conduct active follow-up of all cancer patients from diagnosis to death and have the data for the cause of death, it was possible to compare the three survival rates for selected cancer site within the same study group. The results from

comparisons of the three survival rates for six selected cancer sites within each study group show similar findings. Generally speaking, cause-specific survival rate is better than other two survival estimates; relative survival rate is close to cause-specific survival rate but better than observed survival rate; observed survival rates are always the lowest. The difference became large when the proportion of deaths from other causes was large, for example, for cancers with high survival rates (breast and prostate cancer), for localized cancers, and among old age patients or in the longer term follow-up time periods.

From this study, we can summarize the advantages and disadvantages for these three survival rates as follows:

(1) The cause-specific survival rates for most cancer sites are the highest survival rate among three survival rates. The cause-specific survival rates are obtained disregarding deaths from other causes. The methods for calculating and comparing cause-specific survival rates are same as the methods for observed survival rates except the deaths defined only for cancer under study. However, cause-specific survival rate depend closely upon the quality of information available on causes of death. Sometimes, it is not generally advisable to use this method because of inaccuracies in the classification of the causes of death. For example, it is very difficult to decide whether death results from the secondary effects of treatment (such as, chemotherapy and infection due to treatment) or from the progression of the cancer itself.

(2) Relative survival rates for particular groups of patients were computed by dividing the observed survival rates by survival rates for the subgroup of the general US

population with the same gender, race, and age characteristics as the patient subgroup<sup>[17]</sup>. Relative survival rates usually were very close to cause-specific survival rates in most cancer sites because they both attempt to estimate the effect of cancer alone on survival. In contrast to cause-specific survival rates, relative survival rates does not require the cause of death and thus avoid the difficulties associated with its determination. There is difference in the calculations between cause-specific rates and relative survival rates; the cause-specific survival rates do not attribute to cancer any deaths resulting from the secondary effects of treatment or from diseases caused by the same risk factors as the cancer, but relative survival rates do<sup>[40]</sup>. Consequently, the cause-specific survival rates for most sites are better than those obtained by the method of relative survival. Moreover, to calculate the relative survival rate, we need to obtain an appropriate expected survival rate which will describe the probability of survival for a general population from year to year specified by age, race and sex. The procedure for comparing overall relative survival rates is more complicated than that for cause-specific survival rates. The latter can be done by proportional hazards regression model without any correction which is usually needed for relative survival rates.

(3) Observed survival rates calculate the proportion of persons surviving regardless of the cause of death. It can be calculated using the direct method, the actuarial or Kaplan-Meier method without adjustment. Unlike cause-specific and relative survival, observed survival rates actually should be interpreted as the likelihood of surviving all causes of death, not the likelihood of surviving the cancer under study. As a result, observed survival rates are much lower than those obtained by cause-specific and relative survival rates. This

difference is more obvious in subgroups with higher mortality from other causes of deaths (for example, older age groups), and for cancer sites with low mortality rates, such as breast and prostate cancers or cancers at the localized stage.

## **5.2 Limitations for the study:**

### **5.2.1 Absence of data on variables of potential interest:**

Information relating to the risk factor status of individuals, such as socio-economic status, education, smoking, diet, age at immigration and duration of stay in the United States, was not available in the SEER dataset. Thus, the analysis of incidence and survival rates could not take the potential effects of these factors into account. The inability to adjust for these possible risk factors will limit the interpretation of the findings in this study.

No standard method or approach can be applied in the United States for identification of migrants and their descendants. Errors in the categorization of race and birthplace influenced the interpretation of this study. The categorization of race in the SEER registry generally is obtained from the hospital record (commonly they are obtained by questioning the cancer patient), but the census data are based on self-report. Moreover, we have no information to determine if the accuracy of the variable “race” and “birthplace” differs among first or second generation Chinese immigrants and US born white Americans. It is possible that the coding of race is most accurate in first generation Chinese immigrants because, with lack of fluent English and visible appearances, foreign-born Chinese are more frequently queried about their race. The coding of race is likely to be more accurate in cancer patients than in the general population for each study group, which would tend to make the

observed incidence rates an overestimate of the true incidence rates.

Another important limitation of this study is that there was no information on age at migration or duration of stay in the United States is available. Since the probability that an immigrant to the United States will develop cancer may differ depending on whether the migration was relatively recent or had taken place a number of decades earlier, it would be important to know how long an immigrant has been exposed to environmental changes. Also, immigration from low-risk to high-risk areas in childhood may influence an individual's risk of cancer more strongly than migration during adulthood <sup>[41]</sup>.

### **5.2.2 Selection bias in migrant studies:**

The results of this study should be interpreted with caution for the following reason. As in most migrant studies, there is some degree of selection bias. The migrant population represents a non-random sample of the population of the country of origin. The Chinese immigrants can be assumed to be healthier than the average population in China, either because the fact that seeking new life implies they are more highly educated and energetic, or because of the screening out of the sick and disabled by immigration authorities of US. However, since this study did not compare rates between Chinese immigrants and Chinese in China, this selection bias was less relevant than in other migrant studies. On the other hand, the comparisons between Chinese immigrants and US born white Americans could be affected by this selection bias because the high education level of Chinese immigrants could relate to better socioeconomic status and better health care. As we mentioned above, we had no measure of socioeconomic status. As a result, these possible confounders could be a

problem from the point of view of interpreting the findings for present study.

### **5.2.3 Representativeness of SEER data for the whole population of US:**

Since national data for cancer incidence and survival are not available for US, the SEER Program is the most comprehensive system for tracking cancer incidence and patient survival in the United States. Because the SEER registry areas were not randomly selected, there is no direct mechanism for the evaluation of the representativeness of the SEER incidence and survival data. It is recognized that the population of potential subjects included in SEER is not a random subset of the United States. For instance, the SEER population was designed to oversample minority populations, to permit inclusion of sufficient numbers for analysis. To assess the generalizability of the population included in the SEER registries to the overall US population, Nattinger et al compared the population residing in the geographic areas included in the SEER cancer registries (198 SEER counties) to the population in the rest of the United States (2882 non-SEER counties), regarding factors which may affect the delivery of cancer-related health care, or outcomes of patients with cancer<sup>[42]</sup>. They reported that the population residing within the SEER areas is more affluent, more highly educated, has a lower unemployment rate, and is substantially more urban than the remainder of the US population. The SEER areas have fewer general and family practice physicians, but more total nonfederal physicians, general internists, and specialists relevant to cancer care<sup>[42, 43]</sup>. The difference between the SEER population and the remainder of the United States, especially SEER's higher socioeconomic status and more urban population, should be considered when generalizing from SEER to the entire country. However, the goal of the

present study is focused on comparing the incidence and survival among first and second generation Chinese immigrants and US born white Americans within the same geographic area of SEER population. Therefore, issues in representativeness are less relevant than for other purposes.

### **5.3 Analysis of cancer incidence:**

Recently, some studies which compared the incidence rates of primary cancer for selected cancer sites among US born and foreign born Chinese, Japanese, and Filipino residents of the US with rates among US born whites have been published [10,11,12,13,44,45,46]. The subjects of these studies included all primary cancer cases diagnosed between 1973 and 1986 occurring among individuals 15-84 years of age residing in the San Francisco-Oakland area, the state of Hawaii and western Washington State. Another comparable study was conducted by John W. Horn et al in 1996 also based on SEER data [47]. They reported the incidence rates of selected cancer site for both Asian Americans and US whites cancer cases diagnosed between 1977 and 1983 in San Francisco and Hawaii. The present study has showed many consistent results with these studies. The results of site specific analysis are more important than the results of overall cancer incidence in the context of Chinese migrants. The following is a discussion of the highlights of these findings.

#### **5.3.1 Nasopharyngeal Cancer:**

Nasopharyngeal cancer (NPC) is a disease with a remarkable racial and geographical distribution. It is a rare cancer in most parts of the world where the age-standardized incidence rate for either sex is generally less than 1 per 100,000 persons per year [1]. The

highest rates in the world are found among the southern provinces of Guangdong, Guangxi, Hunan, and Fujian of China <sup>[48]</sup>. Results from this study are consistent with most other migrant studies: first generation Chinese immigrants display an enormous and significant excess incidence of nasopharyngeal cancer relative to US born white Americans (19.5 vs 0.71 in males and 13.4 vs 0.35 in females); the incidence rates for second generation Chinese migrants (6.8 in males and 2.4 in females) decrease and are intermediate between first generation Chinese immigrants and US born white Americans. In contrast, Lee et al reported that Singapore born Chinese do not experience decreased rates of nasopharyngeal cancer relative to China-born Chinese <sup>[49]</sup>. It is interesting to note that the Chinese in southeast Asia generally adhere to their traditional culture and customs, while those in Western countries gradually adopt the total different culture and customs of their host countries. These migrant studies thus suggest that environmental factors may play an important role in the etiology of nasopharyngeal cancer.

### **5.3.2 Esophageal Cancer:**

China has one of the highest incidence rates of esophageal cancer in the world. However, it is rare over large tracts of the country, the disease occurring mainly in a few sharply demarcated areas. Given the variation in rates of Chinese in China, the incidence for Chinese living outside China can be used to assess the effect of migration only if their place of origin in China is known. Our study, similar to many other migrant studies, does not have such information. The results from this study showed that only first generation male Chinese immigrants have significantly higher incidence of esophageal cancer relative to US born

white Americans (RR=1.28 ,95% CI=1.01-1.26). In contrast, the first generation female Chinese immigrants have significant lower incidence of the cancer than US born white Americans (RR=0.53, 95%CI=0.38-0.73). There are no significant differences between the incidence rates for second generation Chinese immigrants and first generation Chinese immigrants, and second generation Chinese immigrants and US born white Americans in both males and females. These results are somewhat unexpected given the findings of other studies, most of which report excess rates at the site compared with host rates. There are some explanations for these outcome. First, since the number of incidence cases in the Chinese was small (especially for females, 23 in total for the first generation and 7 for the second generation), we cannot rule out the role of chance. Second, we cannot identify the place of origin in China where these Chinese migrants came from. It is possible that they came from low-risk areas.

### 5.3.3 Stomach Cancer:

Migrant studies have presented a strong argument that environmental factors assume a dominant role over genetic factors in the occurrence of stomach cancer. Some migrant studies have reported that Japanese and Chinese migrants to Hawaii and their offspring have lower rates than the Japanese in Japan and the Chinese in China<sup>[50]</sup>. Conversely, Indians in Singapore have higher rates than Indians in India<sup>[1]</sup>. Although it is recognized that cancer rates vary geographically within a country of origin, there is a general pattern in which migrants tend to gravitate toward the cancer risk of their adopted country. The results from this study confirmed these findings: the incidence rates of stomach cancer for second

generation Chinese immigrants were intermediate between first generation Chinese immigrants and US born white Americans. The incidence rates of second generation Chinese immigrants were significantly lower than the rates of first generation Chinese immigrants (8.04 vs 13.17 in males and 4.54 vs 9.03 in females). There are no significant differences in incidence rates between second generation Chinese immigrants and US born white Americans in both males and females. However, first generation Chinese immigrants had significantly elevated rates when compared to US born white Americans. Ethnic differences in susceptibility to stomach cancer need to be considered, but it is unlikely that they are mainly due to inherited biological or ethnic traits. Differences in environmental, dietary, and other personal exposures between the ethnic groups could account for much of the variation in rates of stomach cancer.

#### **5.3.4 Liver Cancer:**

China has the world's highest rates of liver cancer while it is a very rare tumor in the United States. As with nasopharyngeal cancer, liver cancer has a large geographic variation in incidence in China. From other migrant studies, the annual incidence rate of liver cancer was 22.1 cases per 100,000 persons in Chinese males recorded in the San Francisco Bay Area tumor registry, seven times higher than the rate among white males in San Francisco<sup>[8]</sup>. A recent study conducted by Rosenblatt et al in 1996 compared the incidence of primary liver cancer in Chinese immigrants and their descendants as well as US born white Americans<sup>[10]</sup>. The data was from population-based cancer registries serving the San Francisco/Oakland metropolitan area, 13 counties of western Washington, and Hawaii during 1973-1986. The

results showed that the rate of liver cancer was higher for men born in China than for Chinese men born in the US, who, in turn, had higher rates than did US born white Americans (respective annual rates per 100,000: Chinese born in China, 26.5; Chinese born in US 9.8; and US born whites 3.3). Their findings for women did not follow as distinct a pattern as for men (respective annual rates per 100,000: Chinese born in China, 2.2; Chinese born in US 3.7; and US born whites 1.1). The results from our study were generally similar to these studies. In men, rates in first generation Chinese immigrants (26.9 per 100,000) were greater than those for second generation Chinese immigrants (13.8 per 100,000), which, in turn were higher than those in US born white Americans (3.1 per 100,000). In women, a similar pattern was found as those in men: rates in first generation Chinese immigrants (6.7 per 100,000) were greater than those for second generation Chinese immigrants (5.0 per 100,000), which, in turn were higher than those in US born white Americans (1.3 per 100,000). However, the 95% CI of relative risk for liver cancer between first generation and second generation Chinese women included 1.0 while the 95% CI of relative risk for liver cancer among men and Chinese women vs US born white Americans did not include 1.0. This perhaps is due to the smaller number of liver cancer cases in second generation Chinese women (21 in total) than in men (52 in total). It is highly likely that the variation in liver cancer incidence among first and second generation Chinese immigrants and US born white Americans reflects the variation in exposure to an environmental etiology, such as exposure to aflatoxins-contaminated foods. Another likely explanation for the variation in liver cancer is the variation in the prevalence of chronic infection with hepatitis B virus<sup>[36]</sup>. Children are believed to acquire hepatitis B infection in one of two ways: “vertically” (from their

mothers), or “horizontally” (from other individuals). The higher incidence of liver cancer in second generation Chinese immigrants relative to US born white Americans could well be the result of their relatively greater likelihood of having been infected with hepatitis B by their mothers <sup>[10]</sup>. However, the relative contribution of these two factors is unclear.

### **5.3.5 Colon and Rectal Cancer:**

The highest incidence rates for colonic cancer in the world are reported in North America, Australia, and New Zealand, while the lowest rates are generally reported in Africa, Asia, and Latin America <sup>[51]</sup>. In general, colonic cancer is relatively more common in economically advantaged populations whose lifestyle is “Westernized”. In contrast to colonic cancer, the incidence of rectal cancer varies internationally to a less extent than that of colonic cancer. A population-based case-control study of colorectal cancer was conducted among Chinese men and women in western North America and the People’s Republic of China<sup>[52,53]</sup>. Their results showed that among Chinese immigrants to North America, the risk of colorectal cancer increased with duration of exposure to a sedentary lifestyle and a diet rich in saturated fat. Yu et al (1991) reported similar finding <sup>[14]</sup>: colon and rectal cancer incidence rates of Chinese-American are higher than that of Chinese in China and similar to that of white Americans. The results from our study indicated that the relative risk of colon and rectal cancers for both male and female in first generation Chinese immigrants are lower than in US born white Americans. Moreover, second generation Chinese immigrants showed slightly lower incidence rates for both colon and rectal cancers than US born white Americans but the differences were not statistically significant, and there was no significant

difference between first and second generation Chinese immigrants. However, many studies of migrant populations in the United States have demonstrated that, for many racial and ethnic groups throughout the world, the risk of colonic and rectal cancer approaches that of the United States born white Americans in the first generation, or after 20 or more years of residence in the United States <sup>[35]</sup>. The risk of colon and rectal cancer appears to change more rapidly and extensively in the first migrating generation than has been evident for gastric, breast, or prostatic cancers. These difference may reflect the relative importance of earlier versus later exposures to carcinogens, genetic factors that influence metabolic processes, and the rapidity and degree of acculturation that is correlated with determinants of the carcinogenic process.

#### **5.3.6 Lung Cancer:**

Lung cancer is common cancer in both the United States and China. In the United States, lung cancer is one of the three most frequently diagnosed cancers in both whites and Chinese ethnic groups in the SEER Registries from 1988-92 <sup>[15]</sup>. Results of lung cancer incidence and mortality for Chinese immigrants compared to that of host population are inconsistent in different migrant studies. Early studies conducted by King reported first generation Chinese immigrants showed a excess risk of mortality of lung cancer compared to US whites<sup>[3,5,6]</sup> , but the risk for second generation Chinese immigrants could not be differentiated from that for US white males. On the other hand, both first and second generation Chinese females have a higher risk of developing lung cancer compared to white females. Fang et al (1996) studied the cancer mortality of Chinese in New York City from

1988 to 1992 <sup>[54]</sup>. They found the death rates for lung cancer were lower for both male and female Chinese living in New York than for either New York City whites or Chinese in China. Our findings are similar to their findings. The US born male and female whites had a higher risk of developing lung cancer than the first and second generation Chinese immigrants. In males, first generation Chinese immigrants had a higher risk to get a lung cancer than second generation Chinese immigrants; there was no difference in the risk of getting lung cancer between first and second generation Chinese females. The results from this study may reflect the etiological factors of cigarette smoking and other environmental factors. One explanation might relate to less cigarette smoking among Chinese immigrants <sup>[55]</sup>; especially, new immigrants who may have lower smoking habits because most of them are well educated and in a relatively limited economic situation <sup>[56]</sup>. The “Healthy immigrant effect” could be another possible explanation. Moreover, the lower risk of getting lung cancer among Chinese immigrants may also be due to the change of other environmental carcinogens, such as air pollution. Higher rates of lung cancer in Chinese females than in US white females have been reported <sup>[3,5,6]</sup>. Smoking is not as common in females in China as it is in Chinese males or in Western females. It has been suggested that exposure to cooking oil may be associated with lung cancer in women rather than tobacco smoking. However, our results did not show a higher incidence of lung cancer in female Chinese than in US born white Americans.

### **5.3.7 Female Breast Cancer:**

There is substantial variation in breast cancer rates among different countries. Rates

are some six times higher in the United States, Canada, or Northern Europe than in Asia <sup>[37]</sup>. Many migrant studies have reported that the international differences in breast cancer rates do not appear to be determined primarily by variation in genetic susceptibility <sup>[14,44,48]</sup>. The study conducted by Yu et al indicated that the incidence rate of female breast cancer in Chinese-Americans was significantly lower than in white Americans, and was significantly higher than the rate in the Chinese in China <sup>[14]</sup>. Stanford et al reported that the rate in Asian-American women born in China or Japan and in their US born counterparts was about 50% and 75% that of US born white Americans, respectively, and was approximately twice the rate found in women residing in Asia <sup>[44]</sup>. The results from our study showed the same trend as theirs in first and second Chinese immigrants and US born white Americans in the United States. Second generation Chinese immigrants had a significantly lower incidence (76.3 per 100,000) than that of US born white Americans(111.0 per 100,000), but they had a significantly higher incidence than that of first generation Chinese immigrants (60.3 per 100,000). This site appears to satisfy the hypothesis of intermediate risk – the rates of second generation immigrants are intermediate between first generation immigrants and those in the adopted country. If the environment is important in the etiology of a disease, we would expect that the second generation immigrants have a rate closer to the rate of host population than the first generation immigrants because they had exposed to the environment of the host country throughout their entire life. One may conclude that exposure to Western lifestyles had a substantial impact on breast cancer risk in Chinese immigrants to the United States during their lifetime.

### **5.3.8 Prostate Cancer:**

There is approximately a 30-fold difference internationally between the highest incidence rate of prostate cancer among African-American men and the lowest rates in Chinese and Japanese men <sup>[8]</sup>. Rates for US and other North American whites are substantially lower than those for blacks, but they are higher than rates elsewhere in the world. Results from this study showed second generation Chinese immigrants have rates which are approximately half that of US whites, but there is still a 1.3-fold higher risk among second generation Chinese immigrants compared to first generation Chinese immigrants. This result is similar to a recent study done by Cook et al (1999) <sup>[46]</sup>. They reported the incidence rates for first generation Chinese immigrants are 24.0 per 100,000 and approximately half that of second generation Chinese immigrants (44.4 per 100,000). These results provided the evidence that these racial differences in prostate cancer incidence are not based entirely on genetic predisposition. However, unlike colon and rectal cancer, the incidence rates of prostate cancer in first and second generation Chinese immigrants are still significantly lower than in US born white Americans. The results suggested that Chinese immigrants retain one or more genetic or lifestyle characteristics that make their risk of prostate cancer less than that of white residents of the United States.

### **5.4 Analysis of cancer survival:**

The main purpose of the survival analysis in this study was to examine the survival pattern among first and second generation Chinese immigrants and US born white Americans. The main prognostic factors for survival rate were considered in this study were:

study groups, gender, age at diagnosis, stage at diagnosis, year of diagnosis, whether the person had directed surgery, cancer registry, and marital status. Before we discuss survival among the three study groups, we need to present some background information about these three study groups. Comparing the distributions of prognostic factors for selected cancer sites among the three study groups, we found second generation Chinese immigrants had a higher percentage of cancer patients from Hawaii registry than the other study groups and first generation Chinese immigrants had a higher percentage of cancer patients from San Francisco-Oakland registry. These distributions were similar to the distributions of first and second generation Chinese population in Hawaii and the San Francisco-Oakland<sup>[31]</sup>. Statistics from US Census Bureau shows that California had both the largest population and the largest numerical increase in the Asian population of any state in the United States in 1998. California is one of the five states with a larger percentage of foreign born population than the percentage for the United states as a whole (others are New York, Florida, New Jersey and Texas). In addition, since the state of Hawaii has its own health insurance coverage system, residents may benefit from better survival due to earlier access to diagnostic and treatment facilities. Moreover, even though we did not have socioeconomic information on study subjects, some information about education and income for Asians and Pacific Islanders in the United States were reported from US Census Bureau. For education, 85% of the Asians and Pacific Islanders age 25 and over had at least a high school diploma, while 42% had earned at least a bachelor's degree. The corresponding proportions for whites were 83% and 25% in 1997. For income, Asians and pacific Islanders had the highest median household income (\$42,276) among all races in the United States in 1996. Among Asians

and Pacific Islanders, 95% were Asian– Chinese, Filipino, Japanese, Korean, and Vietnamese in the United States. This information may help to explain the difference in survival among the three study groups.

Cancer survival rates have been found to vary among different communities and ethnic groups [25,28,57,58]. Differences in lifestyle, culture and environment may explain the difference in cancer survival among ethnic groups. Many papers have been published comparing cancer patient survival experience among ethnic groups for female breast cancer, but very few have been done for other cancer sites. As far as we know, no papers have been published comparing cancer patient survival rates among first and second generation Chinese immigrants for selected cancer sites. We will discuss the results by each selected cancer sites.

#### **5.4.1 Female Breast Cancer:**

From examination of graphs of the survival curves of female breast cancer among the three study groups (figure 4.29-4.31), the second generation Chinese immigrants were observed to have a higher survival rates than other two groups. However, the results of multivariate analysis showed no difference in survival rates among the three study groups after adjusting for other prognosis factors. This shows that the relation between hazard rates and different study groups was affected by other prognostic factors acting as confounders (eg stage at diagnosis which is a very strong factor). From the distribution of prognostic factors in female breast cancer cases, we knew that the second generation Chinese immigrants had a higher percentage of localized stage breast cancer at diagnosis than other study groups. Patients diagnosed at a localized stage had the best survival rates. Moreover, the cancer cases

of second generation Chinese immigrants mainly were from the Hawaii registry(62.2%) which had a better survival rate than that of San Francisco-Oakland registry and other registries. In contrast, only 11% and 1.5% of first generation Chinese immigrants and US born white cases were from Hawaii registry.

It has been suggested that ethnic differences in breast cancer survival are more likely due to environmental than to genetic factors <sup>[27]</sup>. Other prognostic factors often studied in order to explain the survival patterns of ethnic groups are <sup>[59,60]</sup>: marital status, menopausal status, socioeconomic status, utilization of health care services, treatment options and the health status of patients. In this study, patients who did not have cancer directed surgery had a 2-fold higher risk of dying from breast cancer than those who had cancer directed surgery. Being married increased survival probability. Cancer patients who diagnosed before 1983 had better survival than those who diagnosed after 1983. To understand what caused this difference we need more clinical information about the change of diagnosis and screening in the United States. In addition, the youngest age group had a lower survival rate than older age groups. This result was confirmed by other studies <sup>[23]</sup>. A limitation of this study is that no detailed clinical or socioeconomic status information was available that might explain the remaining ethnic differences.

#### **5.4.2 Prostate Cancer:**

Young et al (1984) reported that survival rates of prostate cancer were higher among Oriental males than among either white or black males. Results from our study confirmed their findings <sup>[25]</sup>. The second generation Chinese males had a higher survival rate than US

born white Americans even after adjusting for other prognostic factors. There was no difference in survival of prostate cancer between first and second generation Chinese immigrants after controlling for other prognostic factors. And there was no difference in prostate cancer survival between first generation Chinese immigrants and US born white Americans.

Stage at diagnosis is a crucial prognostic factor for survival from prostate cancer. The localized stage has the highest survival rate, while the distant stage has the lowest survival rates. Patients not having cancer directed surgery had a higher risk of dying from prostate cancer than those who had cancer directed surgery. Married persons had better survival rates than singles. Cancer patients diagnosed in 1983-92 had better survival than those who were diagnosed before 1983. This might be related to the new technology in prostate cancer diagnosis and treatment.

#### **5.4.3 Colorectal Cancer:**

Results from Young et al (1984) indicated that the 5-year relative survival rate of colon cancer for Chinese (51%) was similar to that of whites (49%) [25]. There is a consistent finding from our study. No difference in survival rate existed among first or second generation Chinese immigrants and US born white Americans after adjusting for all other prognostic factors. From the crude comparison of male colon and rectal survival rate among the three study groups, it seemed that second generation Chinese immigrants had better survival rates than the other two groups. The distribution of prognostic factors in colorectal cancer cases indicated that the second generation Chinese immigrants had a higher

percentage of localized stage cancer at diagnosis than other study groups. And they had a higher percentage of having cancer directed surgery during the first course of therapy. Moreover, the cancer cases of second generation Chinese immigrants mainly were from the Hawaii registry (68.1%) which had a better survival rate than that of San Francisco-Oakland registry and other registries. In contrast, only 10.5% and 1.2% of first generation Chinese immigrants and US born white cases were from Hawaii registry which a better survival rate than that of San Francisco-Oakland registry and other registries. However, after controlling for stage at diagnosis, gender, age at diagnosis, cancer registry and other prognostic factors, being a second generation Chinese immigrant no longer was a strong prognostic factor for colorectal cancer survival.

For colorectal cancer, gender was a prognostic factor even after adjusting for the other prognostic factors. Male patients had a lower survival rate than female patients. Stage at diagnosis has a strong effect on survival from colorectal cancer. Patients aged over 65 years old had better survival than those who were younger than that age. A similar result was reported by Wingo et al <sup>[23]</sup>. In their study, white males who were 75 years and older and white females who were at least 65 years of age appeared to have lower survival than patients who were diagnosed at other ages. Patients having cancer directed surgery had a higher survival rate than those who did not have cancer directed surgery during the first course of therapy. Like female breast cancer, patients of colorectal cancer diagnosed before 1983 had better survival than those who diagnosed after 1983. Hawaii patients had better survival rate than that of San Francisco-Oakland and elsewhere.

#### **5.4.4 Lung Cancer:**

Second generation Chinese immigrants had higher survival rates from lung cancer than US born white Americans after controlling for gender, age at diagnosis, stage at diagnosis and other prognostic factors. And also first generation Chinese immigrants had higher survival rates from lung cancer than US born white Americans. There was no difference in survival rates of lung cancer between first and second generation Chinese immigrants. Young et al (1984) reported that the 5-year relative survival rates for lung cancer ranged from a low of 5% among American Indians to a high of 15% among Hawaiians and Chinese <sup>[25]</sup>. Rates for females were higher than those for males. Our study showed a similar result - - the survival rate for females was better than that for males after adjusting for other prognostic factors.

Unlike female breast cancer patients, the younger the age, the better the survival rates of lung cancer patients. Stage at diagnosis had a strong effect on the survival of lung cancer. Risk of dying from lung cancer among patients not having cancer directed surgery was over 2-fold higher than in those who had cancer directed surgery. Like prostate cancer, cases diagnosed from 1983 to 1992 had a higher survival rate than those diagnosed before 1983. Single patients had the worst survival rate among all different marital status patients.

#### **5.4.5 Summary:**

The results of our study suggest that second generation Chinese immigrants had some advantage of survival for prostate and lung cancer. However, this effect is not apparent in breast and colorectal cancer after adjusting for the stage at diagnosis and other prognostic

factors. On the other hand, stage is the strongest prognostic factor for the survival of female breast, prostate, colorectal and lung cancer patients. Gender, age at diagnosis, and cancer directed surgery after diagnosis also play important roles in the survival of these cancers. Some other prognostic factors may also affect the survival of the cancers, such as year of diagnosis, cancer registry, and marital status. Other prognostic factors (such as socioeconomic status and other clinical treatment information) may also affect the survival from these cancers but were not collected in this study. They need to be investigated in further studies.

## **CHAPTER 6 CONCLUSION:**

This thesis compared the incidence and survival rates of selected cancer sites among first and second generation Chinese immigrants and US born white Americans in the United States by using newly released data from the Surveillance, Epidemiology and End Results (SEER) Program of National Cancer Institute (US).

The study of incidence patterns in the second generation Chinese in relation to that in first generation Chinese and in local born white Americans, provides additional information on the relative importance of environmental and genetic factors in etiology. The variables of ethnicity and birthplace are both available in the dataset. This makes it possible to combine them and define the three study groups. Moreover, since cancer cases for each study group came from the same data source, it is unlikely to have different criteria for cancer diagnosis among different study groups. Therefore, the biases caused by data collection are under control for three comparison groups. The results from the incidence analysis of this study are quite in line with those from other studies of this kind. In general, the second generation Chinese immigrants had incidence rates intermediate between first generation Chinese immigrants and US born white Americans in many selected cancer sites. However, they also retained high rates of some cancers (i.e. nasopharyngeal and liver cancers) .

The cause-specific survival rates of second generation Chinese immigrants were somewhat higher than those of US born white Americans for prostate and lung cancers even

after adjustment for other prognosis factors . However, this effect was not strong, there was no statistically significant difference in survival rates between second generation Chinese immigrants and US born white Americans in female breast and colorectal cancers when other strong prognostic factor were controlled. Nevertheless, the ethnic disparity in cancer survival still exists.

In future studies, information on socioeconomic status, utilization of health services, and other clinic treatment methods and health status should be included in Cox models to explain and predict the survival probability among different study groups.

## Reference:

1. Parkin DM. Studies of Cancer in Migrant Populations: Methods and Interpretation. *Review Epidemiology*. 1992; 40: 410-424.
2. Hanley AJG, Choi BCK, Holowaty EJ. Cancer Mortality among Chinese Migrants: A Review. *International Journal of Epidemiology* 1991; 20(1): 76-81.
3. King H, Haenszel W. Cancer Mortality among Foreign and Native-born Chinese in the United States. *Journal of Chronic Diseases* 1973; 26: 623-646.
4. Smith L, Recorded and Expected Mortality among the Chinese in Hawaii and the United States with Special Reference to Cancer. *Journal of National Cancer Institute* 1956; 17: 667-676.
5. King H, Locke FB. Cancer Mortality among Chinese in the United States. *JNCI*; 1980; 65: (5) 1141-1148.
6. King H, Locke FB, Pollack ES, and Tu Ji-Tao. Patterns of Site-Specific Displacement in Cancer Mortality among Migrants: The Chinese in the United States. *American Journal of Public Health* 1985; 75(3): 237-242.
7. Parkin DM. Chen VW. Ferlay J, et al. Comparability and Quality Control in Cancer Registration. IARC Technical Report No. 19. Lyon, 1994.
8. Muir C, Qaterhouse J Mack T, et al. Cancer Incidence in Five Continents, Vol. V. IARC Scientific Publications No. 88, Lyon, International Agency for Research on Cancer. 1987
9. Hanley AJG, Cancer Mortality Patterns among Chinese Migrant Populations in Ontario, Master thesis, University of Toronto, 1992.
10. Rosenblatt KA, Weiss NS, Schwartz SM. Liver Cancer in Asian Migrants to the United States and Their Descendants. *Cancer Causes and Control* 1996; 7: 345-350.
11. Rossing MA, Schwartz SM, Weiss NS. Thyroid Cancer in Asian Migrants to the United States and Their Descendants. *Cancer Causes and Control* 1995; 6: 439-444.
12. Herrinton LJ, Stanford JL, Schwartz SM, Weiss NS. Ovarian Cancer Incidence in Asian Migrants to the US and Their Descendants. *JNCI* 1994; 86: 1336-9.
13. Herrinton LJ, Goldoft M, Schwartz SM, Weiss NS. The Incidence of Non-Hodgkin's Lymphoma and Its Histologic Subtypes in Asian Migrants to the United States and Their Descendants. *Cancer Causes and Control* 1996; 7: 224-230.
14. Yu H, Harris RE, Gao Y, Gao R, Wynder EL. Comparative Epidemiology of Cancers of the Colon, Rectum, Prostate and Breast in Shanghai, China Versus the United States. *International Journal of Epidemiology* 1991; 20(1): 76-81.
15. Miller BA, Kolonel LN, Bernstein L, et al: Racial / Ethnic Patterns of Cancer in the United States 1988-1992 NIH Publication No. 96-4104. 1996.
16. HARRAS A. Tapping the SEER Database. *Cancer Practice* May/June 1995; 3(3): 184-6.

17. Ederer F, Axtell LM, Cutler SJ. The Relative Survival Rate: A Statistical Methodology. Monograph National Cancer Institute 1961; 6:101-121.
18. Esteve J. Benhamou E. Croasdale M. and Raymond L. Relative Survival and the Estimation of Net Survival: Elements for Further Discussion. *Statistics in Medicine* 1990; 9:529-538.
19. Shambaugh EM. Young JL. Zippin C. Lum D. Akers C. and Weiss M. SEER Program: Self-Instruction Manual for Cancer Registrars: Book 7: Statistics and Epidemiology for Cancer Registries, NIH Publication No. 98-3766. 1998.
20. Henson DE, Reis LAG. The Relative Survival Rate. *Cancer* November 1995; 76(10): 1687-88.
21. Howard J, Hankey BF, Greenberg RS, Austin DF, Correa P, Chen VW, and Durako S. A Collaborative Study of Differences in the Survival Rates of Black Patients and White Patients with Cancer. *Cancer (Phila.)* 1992; 69: 2349-2360.
22. Ries LG, Pollack ES, Young JL. Cancer Patient Survival: Surveillance, Epidemiology, and End Results Program, 1973-79. *JNCI* 1983; 70(4) 693-707.
23. Wingo PA, Ries LAG, Parker SL, Heath CW. Long-term Cancer Patient Survival in the United States. April 1998; 7: 271-282.
24. Cox DR. Regression Models and Life-Tables. *Journal of Royal Statistical Society* 1972; 34:187-220.
25. Young JL, Ries LG, and Pollock ES. Cancer patient survival among ethnic groups in the United States. *Journal of the National Cancer Institute.* 1984; 73(2): 341-352.
26. Meng L, Maskarinec G, Wilkens L. Ethnic Differences and Factors Related to Breast Cancer Survival in Hawaii. *International Journal of Epidemiology* 1997; 26(6): 1151-1158.
27. LeMarchand L. Kolonel LN. Nomura AMY. Relationship of ethnicity and other prognostic factors to breast cancer survival patterns in Hawaii. *Journal of National Cancer Institute.* 1984; 73: 1259-65.
28. Meng L. Maskarinec G. Lee J. ethnicity and Conditional Breast Cancer Survival in Hawaii. *Journal Clinical Epidemiology* 1997; 50(11) 1289-96.
29. NIH. SEER Program Public-Use CD-ROM (1973-1995). National Cancer Institute, DCPC, Surveillance Program, Cancer Statistics Branch, released April 1998, Based on the August 1997 Submission.
30. NIH. SEER Program Code Manual, National Cancer Institute, NIH Publication No. 98-2313. 1998.
31. Ruggles S. and Sobek M. Integrated Public Use Microdata Series: Version 2.0. Minneapolis: Minnesota Historical Census Projects, University of Minnesota, 1997.
32. Shryock HS. The Methods and Materials of Demography 1975; 673-720.
33. Green SB and Salkind NJ. Using SPSS for Windows: Analyzing and Understanding Data. Upper Saddle River, NJ: Prentice Hall, 1997.

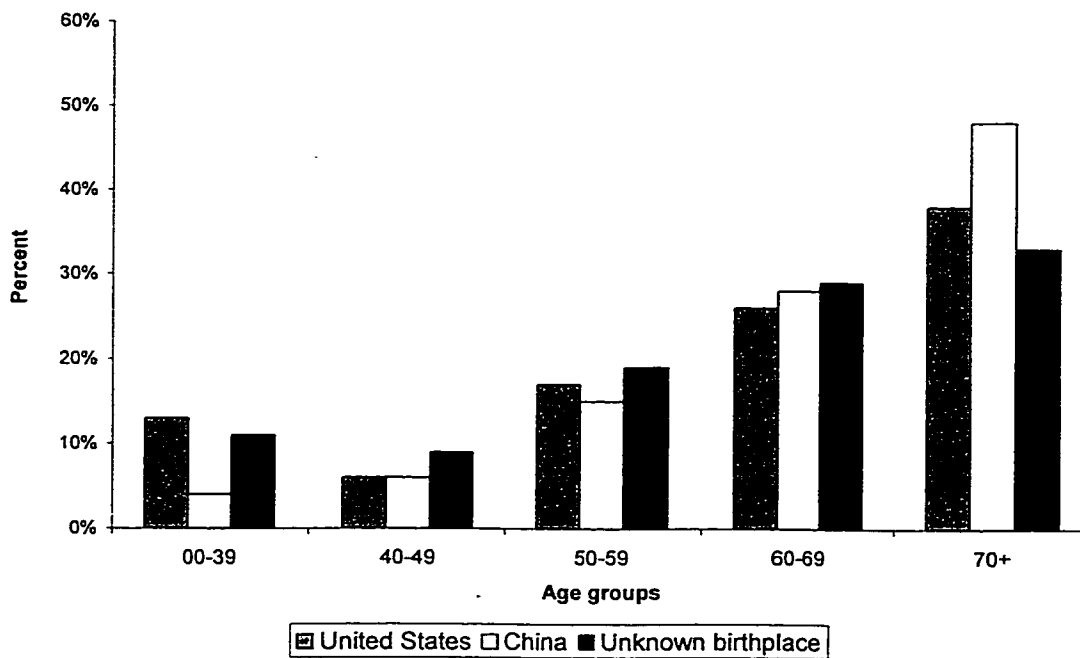
34. Breslow NE, Day NE, *Statistical Method in Cancer Research, Volume II. The Design and Analysis of Cohort Studies* (IARC Scientific Publications No.82), Lyon, International Agency for Research on Cancer, 1987; 64-65.
35. Schottenfeld D. Fraumeni JF. *Cancer Epidemiology and Prevention*, second edition, Oxford University Press, New York Oxford 1996.
36. Armstrong B. The Epidemiology of Cancer in the Peoples Republic of China. *International Journal of Epidemiology*. 1980; 9 (4): 305-315.
37. Parkin DM. Whelan SL. Ferlay J. *Cancer Incidence in Five Continents, Voume VII*. Lyon, France: IARC sicientific publication No.143, Lyon 1997.
38. Cutler SJ, Ederer F. Maximum Utilization of the Life Table Method in Analyzing Survival. *Journal of Chronic Diseases* 1958; 8: 699-712.
39. Gibberd RW. and Hakulinen T. A Relative Survival Analysis Package. *The American Statistician* 1988; 42:230.
40. Esteve J. Benhamou E. Raymond L. *Statistical methods in Cancer Research volume IV - Descriptive epidemiology*, 1994 pp 231-235.
41. Geddes M, Parkin DM, Khlal M, Balzi D, and Buiatti E. *Cancer in Italian Migrant Populations*. Lyon, IARC Scientific Publications No. 123, 1993.
42. Nattinger AB, McAuliffe TL, Schapira MM. Generalizability of the Surveillance, Epidemiology, and End Results Registry Population: Factors Relevant to Epidemiologic and Health Care Research. *Journal of Clinical Epidemiology* 1997; 50 (8): 939-945.
43. Frey CM, McMillen MM, Cowan CD, Horm JW, Kessler LG. Representativeness of the Surveillance, Epidemiology, and End Results Program Data: Recent Trends in Cancer Mortality Rates. *Journal of the National Cancer Institute* 1992; 84: 872-877.
44. Stanford JL, Herrinton LJ, Schwartz SM, Weiss NS. Breast Cancer Incidence in Asian Migrants to the US and Their Descendants. *Epidemiology* 1995; 6: 181-3.
45. Kamineni A, Williams MA, Schwartz SM, Cook LS, Weiss NS. The incidence of gastric carcinoma in Asian migrants to the United States and their descendants. *Cancer Causes Control* 1999; 10(1): 77-83.
46. Cook LS, Goldoft M, Schwartz SM, Weiss NS. Incidence of adenocarcinoma of the prostate in Asian immigrants to the United States and their descendants. *Journal of Urology* 1999;161(1): 152-155.
47. Horm JW, Devesa SS, Burhansstipanov L. Cancer incidence, mortatily, and sruvival among racial and ethnic minority groups in the United States. *Cancer Epidemiology and Prevention*. second edition Oxford University Press 1996; 192-235.
48. Haenszel W. Cancer Mortality among the Foreign-born in the United States. *Journal of National Cancer Institute*. 1961; 26: 37-132.
49. Lee HP, Duffy SW, Day NE, Recent trends in cancer incidence among Singapore Chinese. *International Journal of Cancer*. 1988; 42: 159-166.

50. Kolonel LN. Cancer Patterns of Four Ethnic Groups in Hawaii. *JNCI* Nov.1980; 65(5): 1127-32.
51. Ries LG, Hankey BF, Hurray A, Devesa SS. Cancer incidence, mortality, and patient survival in the United States. *Cancer Epidemiology and Prevention*. second edition Oxford University Press 1996; 168-191.
52. Whittemore AS. Colorectal Cancer Incidence among Chinese in North America and the People's Republic of China: Variation with Sex, Age and Anatomical Site. *International Journal of Epidemiology*. 1989; 18(3): 563-568.
53. Whittemore AS, Wu-Williams AH, Lee M, Zheng S, Gallagher RP, Jiao D, Zhou L, Wang X, Chen K, Jung D, Teh C, Ling C, Xu J, Paffenbarger RS, Henderson BE. Diet Physical Activity, and Colorectal Cancer among Chinese in North America and China. *Journal of the National Cancer Institute*. 1990; 82(11): 915-26.
54. Fang J, Madhavan S, Alderman MH. Cancer Mortality of Chinese in New York City 1988-92. *International Journal of Epidemiology* 1996; 25(5): 907-912.
55. Liu Z. Smoking and lung cancer in China: combined analysis of eight case-control studies. *International Journal of Epidemiology*. 1992; 21:197-201.
56. Luo W, Cancer Incidence Patterns among Chinese Immigrant Populations in Alberta. Master thesis, University of Ottawa, 1998.
57. Frost F, Tollestrup K, Hunt WC, Gilliland F, Key CR, Urbina CE. Breast cancer survival among New Mexico Hispanic, American Indian, and non-Hispanic white women (1973-1992). *Cancer Epidemiology, Biomarkers & Prevention* 1996 Nov;5(11):861-6.
58. Keller DM, Peterson EA, Silberman G. Survival Rates for Four Forms of Cancer in the United States and Ontario. *American Journal of Public Health* July 1997; 87(7): 1164-1167.
59. Zahl P-H. And Tretli S. Long-term Survival of Breast Cancer in Norway by Age and Clinical Stage. *Statistics in Medicine* 1997; 16: 1435-1449.
60. Antel LM, Meyers MH. Contrasts in survival of Black and White cancer patients, 1960-73. *Journal of the National Cancer Institute*. 1978; 60(6): 1209-1215.
61. Forst F, Tollestrup K, Hunt WC, Gilliland F, Key CR, Urbina CE, Breast cancer survival among New Mexico Hispanic, American Indian, and non-Hispanic white women (1973-92). *Cancer Epidemiology, Biomarkers & Prevention* Nov. 1996; 5(11): 861-866.
62. Kleinbaum DG, *Survival Analysis—A Self-Learning Text*. 1996 Springer-Verlag New York Berlin Heidelberg ISBN 0-387-94543-1.

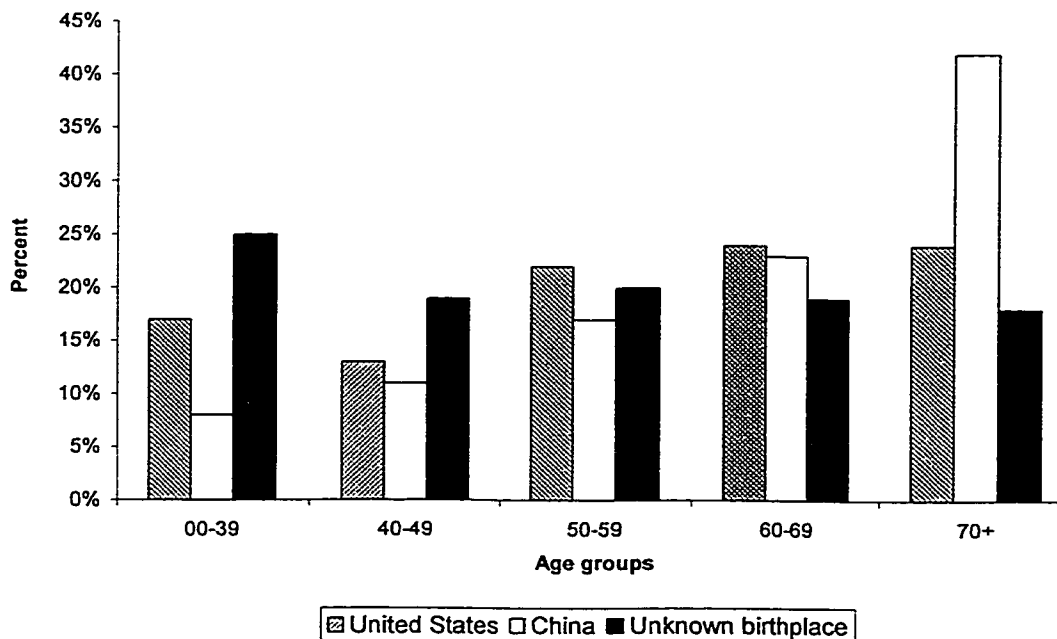
## **Appendix A**

Distributions of cancer cases by age, sex and selected cancer sites among Chinese and white and unknown birthplace groups.

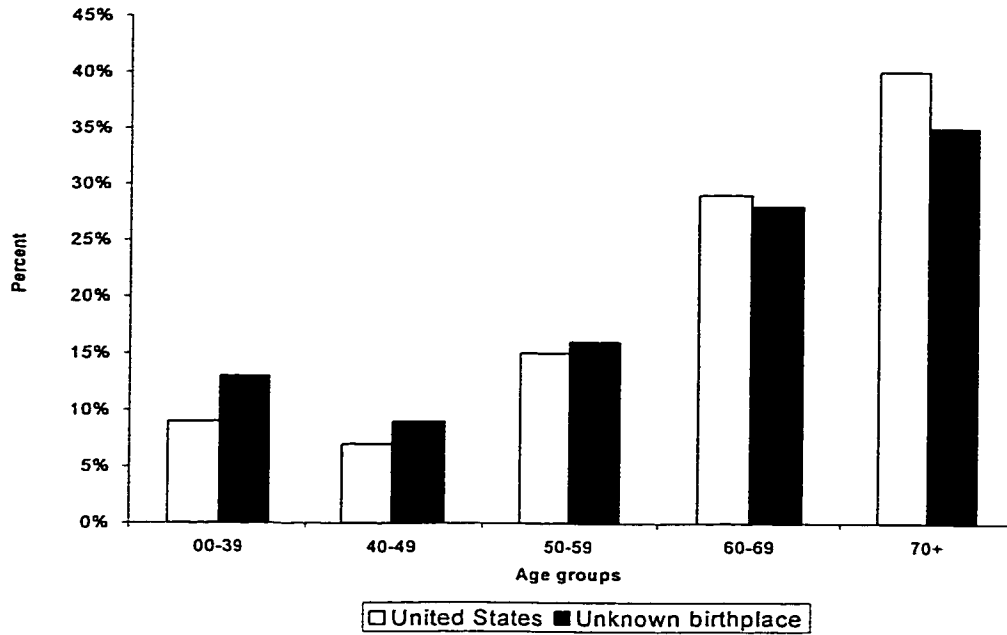
**Figure I. Distribution of cancer cases by age and birthplace in Chinese males, San Francisco, 1973-92**



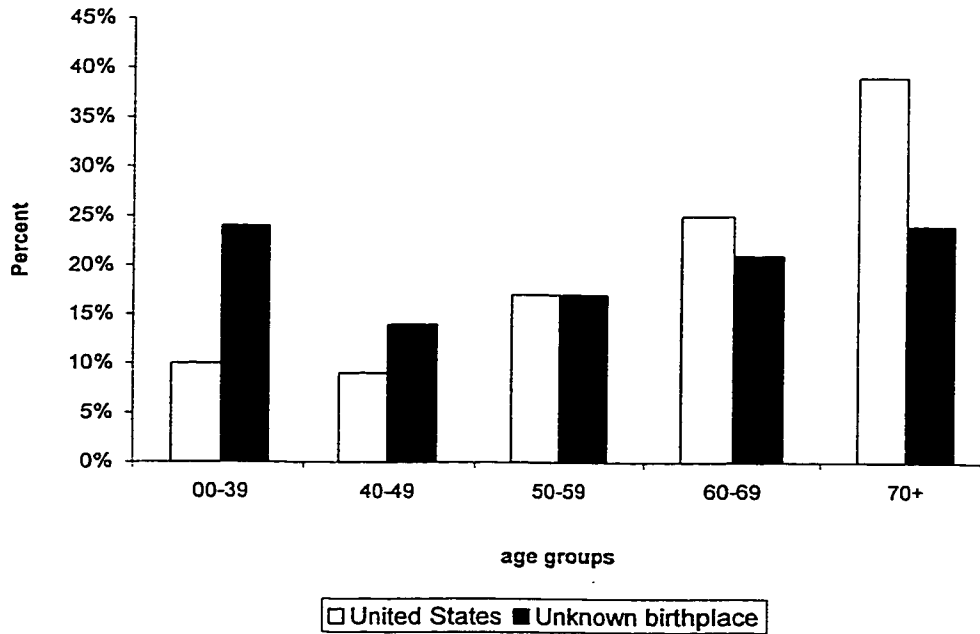
**Figure II. Distribution of cancer cases by age and birthplace in Chinese females, San Francisco, 1973-92**



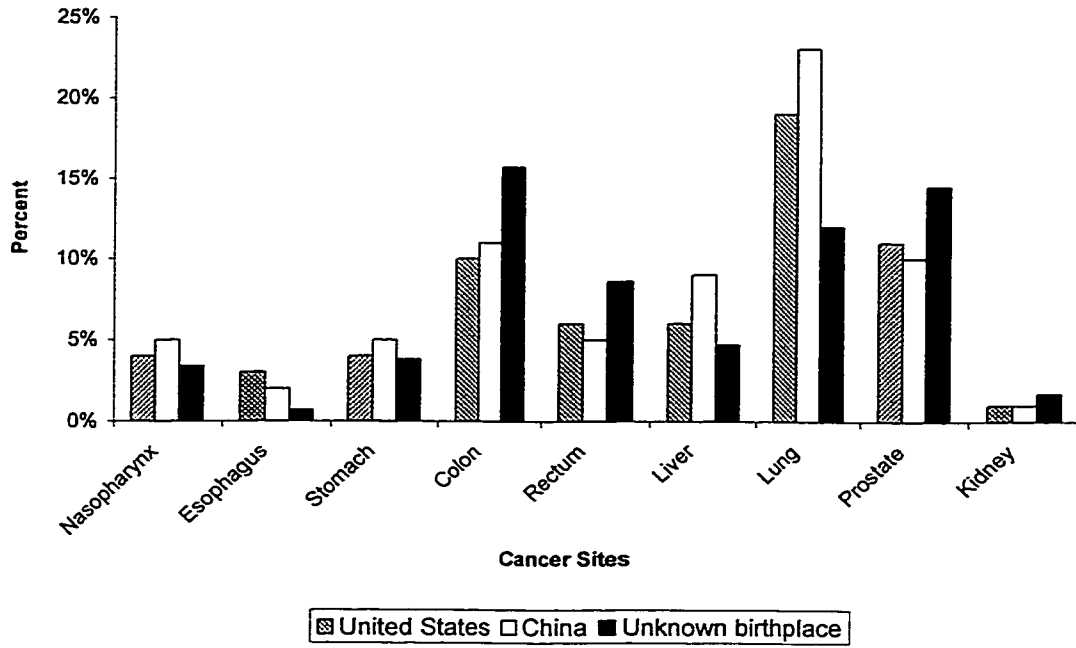
**Figure III. Distribution of cancer cases by age and birthplace in white males, San Francisco, 1973-92**



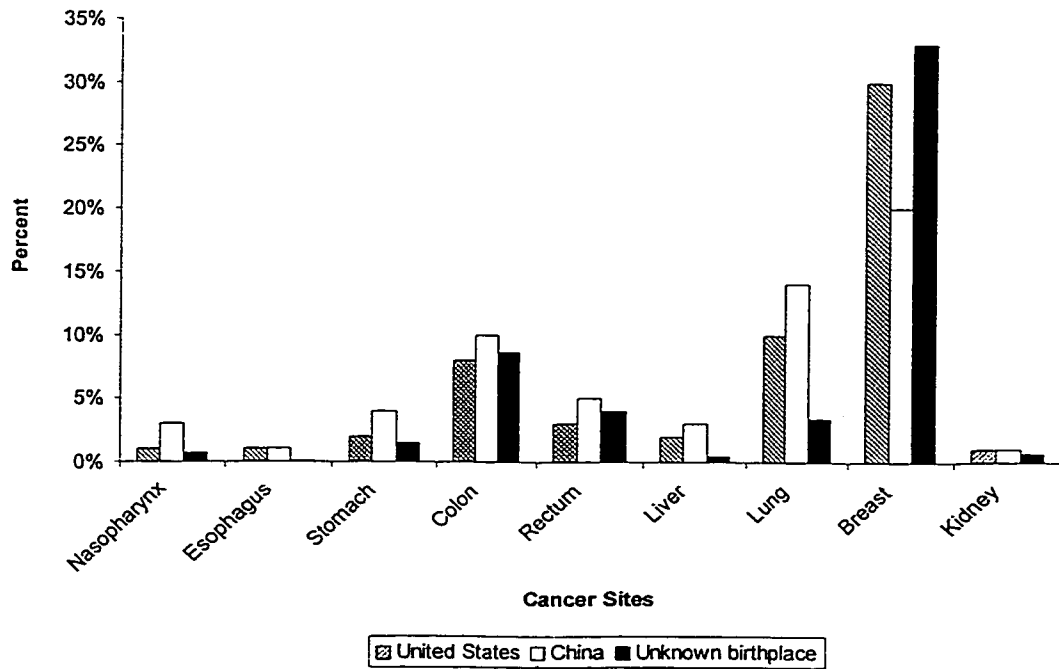
**Figure IV. Distribution of cancer cases by age and birthplace in white females, San Francisco, 1973-92**



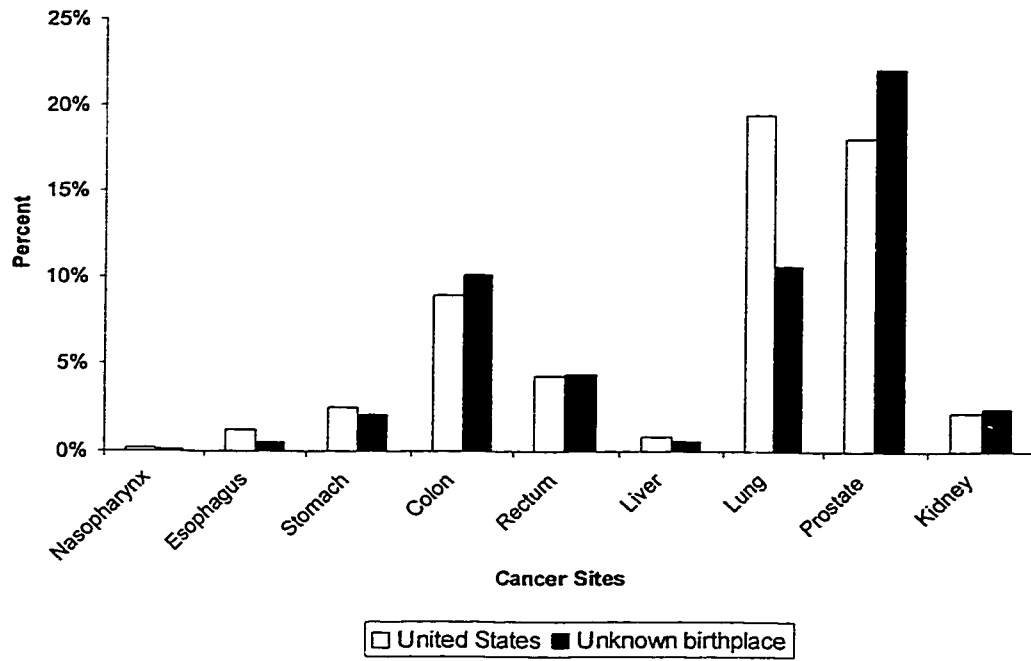
**Figure V. Distribution of cancer cases by site and birthplace in Chinese males, San Francisco, 1973-92**



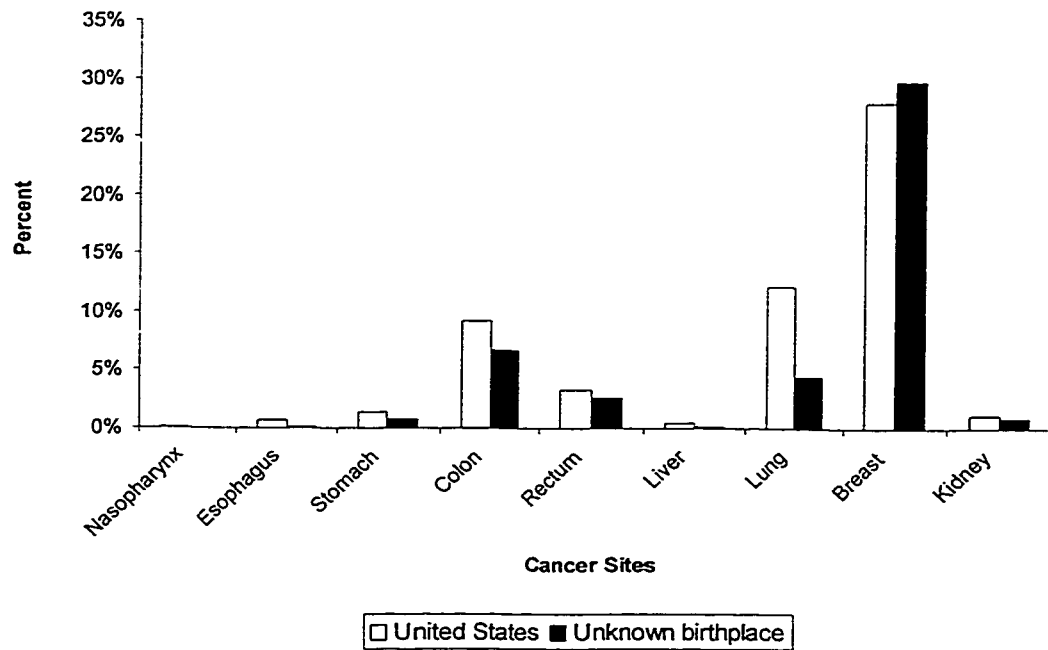
**Figure VI. Distribution of cancer cases by site and birthplace in Chinese females, San Francisco, 1973-92**



**Figure VII. Distribution of cancer cases by site and birthplace in white males, San Francisco, 1973-92**



**Figure VIII. Distribution of cancer cases of site and birthplace in white females, San Francisco, 1973-92**



**Appendix B:**

Procedure of adjustment for unknown birthplace cancer cases:

Table I Distribution of cancer cases by age, sex and birthplace in white and Chinese groups  
(including birthplace unknown) San Francisco, 1973-92

Age Birthplaces	<40		40-49		50-59		60-69		70+		total	
	number	%	number	%	number	%	number	%	number	%	number	%
White Males												
United States	7008	65.9	5540	67.7	11820	70.0	23213	70.5	32171	63.5	79752	66.8
China	6	0.1	11	0.1	26	0.2	89	0.3	113	0.2	245	0.2
other places	773	7.3	704	8.6	1499	8.8	3343	10.2	10609	20.9	16928	14.2
unknown places	2845	26.7	1926	23.6	3550	21.0	6266	19.0	7791	15.4	22378	18.8
Total <sup>1</sup>	10632	100.0	8181	100.0	16895	100.0	32911	100.0	50684	100.0	119303	100.0
White Females												
United States	8206	44.8	7881	54.3	14172	61.9	21549	65.6	33398	65.2	85206	61.0
China	20	0.1	22	0.2	50	0.2	81	0.2	130	0.3	303	0.2
other places	1267	6.9	1417	9.8	2323	10.2	3352	10.2	8977	17.5	17336	12.4
unknown places	8827	48.2	5187	35.7	6336	27.7	7887	24.0	8693	17.0	36930	26.4
Total <sup>1</sup>	18320	100.0	14507	100.0	22881	100.0	32869	100.0	51198	100.0	139775	100.0
Total <sup>2</sup>	28952		22688		39776		65780		101882		259078	
Chinese Males												
United States	93	25.3	43	12.9	125	14.8	187	12.9	269	11.7	717	13.5
China	154	42.0	201	60.2	524	62.2	991	68.4	1728	74.9	3598	67.9
other places	39	10.6	23	6.9	55	6.5	57	3.9	65	2.8	239	4.6
unknown places	81	22.1	67	20.0	139	16.5	213	14.8	244	10.6	744	14.0
Total <sup>1</sup>	367	100.0	334	100.0	843	100.0	1448	100.0	2306	100.0	5298	100.0
Chinese Female												
United States	139	19.6	101	14.2	175	18.1	188	16.5	194	11.2	797	15.2
China	229	32.3	343	48.3	505	52.2	688	60.6	1280	73.8	3045	57.9
other places	52	7.3	48	6.8	53	5.5	43	3.8	49	2.8	245	4.7
unknown places	288	40.7	218	30.7	234	24.2	217	19.1	211	12.2	1168	22.2
Total <sup>1</sup>	708	100.0	710	100.0	967	100.0	1136	100.0	1734	100.0	5255	100.0
Total <sup>2</sup>	1075		1044		1810		2584		4040		10553	

<sup>1</sup> Total cases in one gender group.

<sup>2</sup> Total cases in both gender groups.

Table II Distribution of cancer cases by age, sex and birthplace in white and Chinese groups  
(excluding birthplace unknown) San Francisco, 1973-92

Age	<40		40-49		50-59		60-69		70+		total	
	number	%	number	%	number	%	number	%	number	%	number	%
White Males												
United States	7008	90.0	5540	88.6	11820	88.6	23213	87.1	32171	75.0	79752	82.3
China	6	0.1	11	0.2	26	0.2	89	0.3	113	0.3	245	0.3
other places	773	9.9	704	11.2	1499	11.2	3343	12.6	10609	24.7	16928	17.5
Total <sup>1</sup>	7787	100.0	6255	100.0	13345	100.0	26645	100.0	42893	100.0	96925	100.0
White Females												
United States	8206	86.4	7881	84.6	14172	85.7	21549	86.3	33398	78.6	85206	82.8
China	20	0.2	22	0.2	50	0.3	81	0.3	130	0.3	303	0.3
other places	1267	13.4	1417	15.2	2323	14.0	3352	13.4	8977	21.1	17336	16.9
Total <sup>1</sup>	9493	100.0	9320	100.0	16545	100.0	24982	100.0	42505	100.0	102845	100.0
Total <sup>2</sup>	17280		15575		29890		51627		85398		199770	
Chinese Males												
United States	93	32.5	43	16.1	125	17.8	187	15.1	269	13.0	717	15.7
China	154	53.8	201	75.3	524	74.4	991	80.2	1728	83.8	3598	79.0
other places	39	13.7	23	8.6	55	7.8	57	4.7	65	3.2	239	5.3
Total <sup>1</sup>	286	100.0	267	100.0	704	100.0	1235	100.0	2062	100.0	4554	100.0
Chinese Females												
United States	139	33.1	101	20.5	175	23.9	188	20.5	194	12.7	797	19.5
China	229	54.5	343	69.7	505	68.9	688	74.9	1280	84.0	3045	74.5
other places	52	12.4	48	9.8	53	7.2	43	4.7	49	3.3	245	6.0
Total <sup>1</sup>	420	100.0	492	100.0	733	100.0	919	100.0	1523	100.0	4087	100.0
Total <sup>2</sup>	706		759		1437		2154		3585		8641	

<sup>1</sup> Total cases in one gender group.

<sup>2</sup> Total cases in both gender groups.

Table III Calculate the adjusted cases by age for missing birthplace group in Whites, San Francisco, 1973-92

Age Birth place	<40		40-49		50-59		60-69		70+		total	
	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust		
White Males												
United States	7008	9568	5540	7246	11820	14964	23213	28672	32171	38014	79752	98165
China	6	8	11	14	26	33	89	110	113	134	245	302
Other places	773	1055	704	921	1499	1898	3343	4129	10609	12536	16928	20836
Unknown places	2845		1926		3550		6266		7791		22378	
Total <sup>3</sup>	10632	10631	8181	8181	16895	16895	32911	32911	50684	50684	119303	119303
Total <sup>4</sup>	7787		6255		13345		26645		42893		96925	
White Female												
United States	8206	15836	7881	12267	14172	19599	21549	28352	33398	40228	85206	115802
China	20	39	22	34	50	69	81	107	130	157	303	412
Other places	1267	2445	1417	2206	2323	3213	3352	4410	8977	10813	17336	23561
Unknown places	8827		5187		6336		7887		8693		36930	
Total <sup>3</sup>	18320	18320	14507	14507	22881	22881	32869	32869	51198	51198	139775	139775
Total <sup>4</sup>	9493		9320		16545		24982		42505		102845	
Total <sup>5</sup>	28952		22688		39776		65780		101882		259078	

<sup>3</sup> Total cases include birthplace unknown cases for before adjust data in one gender group.

<sup>4</sup> Total cases exclude birthplace unknown cases for before adjust data in one gender group.

<sup>5</sup> Total cases included birthplace unknown cases for before adjust data in both gender groups.

Table IV Calculate the adjusted cases by age for missing birthplace group in Chinese, San Francisco, 1973-92

Age	<40		40-49		50-59		60-69		70+		total	
	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust
Chinese Males												
United States	93	119	43	54	125	150	187	219	269	301	717	834
China	154	198	201	251	524	627	991	1162	1728	1932	3598	4186
Other places	39	50	23	29	55	66	57	67	65	73	239	278
Unknown places	81		67		139		213		244		744	
Total <sup>3</sup>	367	367	334	334	843	843	1448	1448	2306	2306	5298	5298
Total <sup>4</sup>	286		267		704		1235		2062		4554	
Chinese Females												
United States	139	234	101	146	175	231	188	232	194	221	797	1025
China	229	386	343	495	505	666	688	850	1280	1457	3045	3915
Other places	52	88	48	69	53	70	43	53	49	56	245	315
Unknown places	288		218		234		217		211		1168	
Total <sup>3</sup>	708	708	710	710	967	967	1136	1135	1734	1734	5255	5255
Total <sup>4</sup>	420		492		733		919		1523		4087	
Total <sup>5</sup>	1075		1044		1810		2584		4040		10553	

<sup>3</sup> Total cases include birthplace unknown cases for before adjust data in one gender group.

<sup>4</sup> Total cases exclude birthplace unknown cases for before adjust data in one gender group.

<sup>5</sup> Total cases included birthplace unknown cases for before adjust data in both gender groups.

Table V. calculate the adjusted cases by site for unknown birthplace group in US born white Americans, San Francisco, 1973-92

Age	<40		40-49		50-59		60-69		70+		total	
	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust
US born white Males												
Nasopharynx (147)	22	30	10	13	43	54	35	43	27	32	137	169
Esophagus (150)	15	20	48	63	166	210	363	448	397	469	989	1221
Stomach (151)	50	68	92	120	332	420	639	789	885	1046	1998	2467
Colon (153)	138	188	232	303	882	1117	2114	2611	3732	4410	7098	8763
Rectum (154)	72	98	171	224	556	704	1167	1441	1455	1719	3421	4224
Liver (155)	31	42	39	51	114	144	206	254	244	288	634	783
Lung (162)	172	235	877	1147	3099	3923	5626	6949	5720	6759	15494	19129
Prostate (185)	3	4	85	111	954	1208	4459	5508	8932	10554	14433	17819
Kidney (189)	72	98	152	199	352	446	575	710	622	735	1773	2189
others	6433	8783	3834	5015	5322	6738	8029	9917	10157	12002	33775	41700
All Sites (140-208, Except 173)	7008	9566	5540	7246	11820	14964	23213	28670	32171	38014	79752	98464
Total <sup>6</sup>	9568		7246		14964		28672		38014		98464	
US born white Females												
Nasopharynx (147)	6	12	8	12	13	18	26	34	21	25	74	101
Esophagus (150)	2	4	18	28	90	124	179	236	293	353	582	794
Stomach (151)	20	39	41	64	129	178	266	350	771	929	1227	1675
Colon (153)	67	129	219	341	706	976	1746	2297	5081	6120	7819	10671
Rectum (154)	36	69	110	171	360	498	695	914	1626	1959	2827	3858
Liver (155)	13	25	29	45	48	66	78	103	175	211	343	468
Lung (162)	127	245	685	1066	2045	2828	3575	4704	3973	4785	10405	14200
Breast (174)	1399	2700	3567	5552	4942	6834	6046	7955	7894	9508	23848	32546
Kidney (189)	54	104	69	107	146	202	250	329	425	512	944	1288
others	6482	12509	3135	4880	5693	7873	8688	11431	13139	15826	37137	50681
All Sites (140-208, Except 173)	8206	15836	7881	12266	14172	19597	21549	28353	33398	40228	85206	116282
Total <sup>6</sup>	15836		12267		19599		28352		40228		116282	

<sup>6</sup> Total is the total adjusted case of each age group in US born white Americans for one gender group.

Table VI. calculate the adjusted cases by site for unknown birthplace group in first generation Chinese immigrants, San Francisco, 1973-92

Age	<40		40-49		50-59		60-69		70+		total	
	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust
First generation Chinese Males												
Nasopharynx (147)	30	39	47	59	50	60	44	52	11	12	182	212
Esophagus (150)	1	1	4	5	16	19	25	29	41	46	87	101
Stomach (151)	7	9	12	15	32	38	45	53	92	103	188	219
Colon (153)	8	10	12	15	48	57	94	110	244	273	406	472
Rectum (154)	3	4	7	9	24	29	62	73	100	112	196	228
Liver (155)	22	28	30	37	84	101	96	113	85	95	317	369
Lung (162)	6	8	27	34	120	144	279	327	398	445	830	966
Prostate (185)	0	0	1	1	6	7	80	94	272	304	359	418
Kidney (189)	0	0	2	2	12	14	19	22	17	19	50	58
others	77	99	59	74	132	158	247	290	468	523	983	1144
All Sites (140-208, Except 173)	154	198	201	251	524	627	991	1163	1728	1932	3598	4187
Total <sup>7</sup>	198		251		627		1162		1932		4186	
First generation Chinese Females												
Nasopharynx (147)	25	42	23	33	27	36	15	19	9	10	99	127
Esophagus (150)	0	0	0	0	3	4	6	7	9	10	18	23
Stomach (151)	6	10	7	10	14	18	27	33	68	77	122	157
Colon (153)	7	12	11	16	51	67	68	84	180	205	317	408
Rectum (154)	1	2	10	14	13	17	47	58	68	77	139	179
Liver (155)	4	7	4	6	14	18	24	30	41	47	87	112
Lung (162)	7	12	12	17	59	78	114	141	247	281	439	564
Breast (174)	59	99	128	185	125	165	138	170	160	182	610	784
Kidney (189)	0	0	4	6	4	5	6	7	17	19	31	40
others	120	202	144	208	195	257	243	300	481	548	1183	1521
All Sites (140-208, Except 173)	229	386	343	495	505	665	688	849	1280	1456	3045	3915
Total <sup>7</sup>	386		495		666		850		1457		3915	

<sup>7</sup> Total is the total adjusted case of each age group in first generation Chinese immigrants for one gender group.

Table VII. calculate the adjusted cases by site for unknown birthplace group in second generation Chinese immigrants, San Francisco, 1973-92

Age	<40		40-49		50-59		60-69		70+		allage	
	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust	Before Adjust	After Adjust
Second generation Chinese Males												
Nasopharynx (147)	10	13	6	6	7	3	4	1	1	26	30	
Esophagus (150)	0	0	2	3	7	8	5	6	8	9	22	26
Stomach (151)	0	0	1	1	7	8	6	7	12	13	26	30
Colon (153)	3	4	3	4	8	10	19	22	37	41	70	81
Rectum (154)	2	3	2	3	5	6	22	26	15	17	46	54
Liver (155)	0	0	5	6	12	14	14	14	15	17	44	51
Lung (162)	6	8	8	10	31	37	43	50	49	55	137	159
Prostate (185)	0	0	0	0	7	8	24	28	51	57	82	95
Kidney (189)	0	0	1	1	2	2	3	4	4	4	10	12
others	72	92	15	19	40	48	50	59	77	86	254	295
All Sites (140-208, Except 173)	93	120	43	55	125	148	187	220	269	300	717	833
Total <sup>8</sup>	119		54	150		219			301		834	
Second generation Chinese Females												
Nasopharynx (147)	3	5	2	3	1	1	1	1	2	2	9	12
Esophagus (150)	0	0	0	0	1	1	2	2	2	2	5	6
Stomach (151)	0	0	0	0	1	1	4	5	9	10	14	18
Colon (153)	2	3	1	1	8	11	19	23	36	41	66	85
Rectum (154)	1	2	0	0	7	9	10	12	8	9	26	33
Liver (155)	2	3	0	0	0	0	4	5	10	11	16	21
Lung (162)	3	5	4	6	23	30	29	36	18	21	77	99
Prostate (185)	38	64	51	74	55	73	59	73	40	46	243	313
Kidney (189)	1	2	0	0	4	5	2	2	2	2	9	12
others	89	150	43	62	75	99	58	72	67	76	332	427
All Sites (140-208, Except 173)	139	234	101	146	175	230	188	231	194	220	797	1026
Total <sup>8</sup>	234		146	231		232			221		1025	

<sup>8</sup> Total is the total adjusted case of each age group in second generation Chinese immigrants for one gender group.

## **Appendix C**

Variables coding sheet for Cox proportional hazard regression

Coding sheet for prognostic variables in Cox proportional hazard regression

Variables	Coding							
<b>Sex</b>								
Male	0							
Female	1							
<b>Study Groups</b>								
Second generation Chinese immigrants	0	0						
First generation Chinese immigrants	1	0						
US born whites	0	1						
<b>Age at Diagnosis</b>								
0-44	0	0	0					
45-64	1	0	0					
65-74	0	1	0					
75+	0	0	1					
<b>Stage at Diagnosis</b>								
Localized	0	0						
Regional	1	0						
Distant	0	1						
<b>Surgery</b>								
Directed Surgery	0							
No Directed Surgery	1							
<b>Year of Diagnosis</b>								
1973-1982	0							
1983-1992	1							
<b>SEER Registries</b>								
San Francisco-Oakland	0	0	0	0	0	0	0	0
Connecticut	1	0	0	0	0	0	0	0
Metropolitan Detroit	0	1	0	0	0	0	0	0
Hawaii	0	0	1	0	0	0	0	0
Iowa	0	0	0	1	0	0	0	0
New Mexico	0	0	0	0	1	0	0	0
Seattle (Puget Sound)	0	0	0	0	0	1	0	0
Utah	0	0	0	0	0	0	1	0
Metropolitan Atlanta	0	0	0	0	0	0	0	1
<b>Marital Status</b>								
Single	0	0	0					
Married	1	0	0					
Separated/Divorced/Widowed	0	1	0					
Unknown Status	0	0	1					

## Appendix D

### Actuarial Method for Survival Analysis

The actuarial method is the most commonly used method in medical follow-up studies. It was first proposed by Frost (1933) in a follow-up study of tuberculosis patients, and later described by Berkson and Gage (1950), Merrell and Shulman (1955), Cutler and Ederer (1958), and others. This method divides the follow-up time into a number of fixed intervals (usually one year in length). It proceeds to estimate overall survival by computing conditional survival within each interval and then cumulating the conditional survival probabilities into an overall survival probability. The method is based on the assumption that each withdrawal or censored observation was observed for half of the interval. It also makes the assumption that the censoring is non-informative.

The formula for the estimation of the conditional probability of Survival is:

$$P_x = 1 - \frac{D_x}{N_x - \frac{1}{2}W_x} \quad (1.0)$$

$x$ : is the exact number of years of follow-up and the typical interval will be denoted by  $(x, x+1)$ .

$P_x$ : is the probability that a patient alive at time  $x$  will survive to the end of the interval  $(x, x+1)$ .

$D_x$ : is the number of patients die in the interval.

$N_x$ : is the number of patients alive at the beginning of the interval.

$W_x$ : is the number of patients withdraw in the interval..

The overall probability of survival to time 'x' is given by this formula:

$$S(x) = P_0 P_1 \dots P_x$$

If the ratio in (1.0) is regarded as a binomial proportion in  $(N_x - \frac{1}{2}W_x)$  trials, then the sample variance is:

$$Var(P_x) = \frac{1}{N_x - \frac{1}{2}W_x} P_x Q_x \quad (2.0)$$

$Q_x$  is the probability that a patient will die during the interval, so that  $Q_x = 1 - P_x$ .

Formula (2.0) is derived entirely on an intuitive and heuristic basis. But its simplicity makes this method well accepted in epidemiological and medical research.

Reference for this appendix is Chin Long Chiang, The life table and its applications.

Robert E. Krieger Publishing Company 1984. ISBN 0-89874-570-5.