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The cancer experience of Texans differs substantially by race/ethnicity. Among Caucasian, African American, and Hispanic men and women, colon cancer is either the second or third leading type of cancers among Texans. The distribution of time to death over a six-year period were assessed from a cohort of African American, Hispanic, and Caucasian men and women diagnosed with colon cancer in 1992. The purpose of this study is to determine if there is a difference in the overall death time distribution and tumor histology among African Americans, Hispanics, and Caucasian men and women who were diagnosed with colon cancer in 1992 in the state of Texas. Analysis results indicated that Hispanic females (65.59%) and Caucasian males (65.52%) had higher survival times among the race/ethnic groups. African American males (53.85%) and females (56.40%) experienced lower survival times for the cohort. African American males experienced the lowest survival time for the cohort. For overall distribution of time to death among deceased subjects, African American males and Hispanic females experienced the lowest distribution times among the subjects. The overall distribution of time to death for all histology types were the same for each type.

A SIX-YEAR ANALYSIS OF THE DISTRIBUTION OF TIME TO DEATH AMONG COLORECTAL CANCER PATIENTS IN THE STATE OF TEXAS

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CHAPTER I

INTRODUCTION

Background

Cancer is not a modern disease but one that has existed for many centuries (Boyd, 1999). Today, cancer is the second leading cause of death in the United States (NCCDPHP, 2000). Colorectal cancer, cancer of both the colon and rectum, is the second leading cancer killer among Americans and the third most common cancer in men and women (National Cancer Institute, 2000). The digestive tract is a major site of cancers in humans (Parkin, 1992). In fact, the large intestine of the gastrointestinal tract harbors disease much more commonly than the small intestine (Well and Halsted, 1967). Together the colon and rectum make up the large bowel, or large intestine. The colon refers to the upper five or six feet of the large intestine, the rectum to the last five or six inches. Because of the anatomic and physiologic similarity of tissue in the colon and rectum and the occasional difficulty in determining in which region a tumor has arisen, malignancies in these two bowel segments are often lumped together as "colorectal cancer" (Harras, 1996).

The colon is comprised of four sections: the ascending colon (first section), the transverse colon (second section), the descending colon (third section), and the sigmoid colon (fourth colon). Cancer can develop in any of the four sections of the colon or in the rectum. Before a true cancer develops, there are usually precancerous changes in the

lining of the colon or rectum. A true cancer can grow inward toward the hollow part of the colon or rectum, and/or outward through the wall of these organs. If untreated, cells from the tumor may break away and spread through the bloodstream or lymph system to other parts of the body. There, they can form "colony" tumors, and this process is known as metastasis. Having adenomatous polyps, also known as adenomas, increase a person's risk of developing cancer, especially if there are many polyps or they are large. Over 95% of colorectal cancers are adenocarcinomas (American Cancer Society, 2000). Carcinomas of the large bowel are among the most common malignant tumors in the body (Well and Halsted, 1967). The lifetime risk of being diagnosed with colorectal cancer in the United States is 6.14% in men and 5.92% in women, and the lifetime risk of dying from this disease is 2.60% in men and 2.65% in women (Sandler, 1996). Geographic, environmental, cultural, racial, gender, and age-related factors all play a role in cancer epidemiology (Newland, 1995). Numerous epidemiologic studies suggest that rates of occurrence of colorectal adenocarcinoma at particular anatomic subsites (e.g., right colon, left colon, and rectum) may be associated with distinctive geographic, demographic, and risk factor profiles (Demers, 1997). Countries and regions with the highest per capita dietary fiber consumption tend to have the lowest colorectal cancer rates (Harras, 1996). Although the exact cause of colorectal cancer is unknown, many epidemiologists have made a strong correlation between the traditional low-fiber, high-

protein, high-fat content diet consumed by people in the Western world (DeCosse, 1986). Migrant and other studies have provided very strong evidence that colorectal cancer risk is modifiable, and that differences in population rates may therefore be explained by lifestyle or environmental factors (Miller, 1996).

Hypothesis

In the state of Texas, African Americans have the highest overall cancer rate (430.8 per 100,000), followed by Caucasian (382.8) and other races, including Hispanics. Hispanics have the lowest total cancer rate, with 263.3 per 100,000. Among Caucasian, African American, and Hispanic men and women, colon cancer is either the second or third leading types of cancers among Texans (Carozza, 1999).

The hypothesis of this study is to determine if there is a difference in the distribution of time to death among Caucasian, African American, and Hispanic men and women who were diagnosed with colon cancer in 1992 in the state of Texas.

Objectives

The objectives of this study were:

1) To determine if a disparity in death time distribution exists between African American, Hispanic, and Caucasian colorectal cancer patients;
2) To determine what histology type(s) might contribute to the ethnic and gender differences in colorectal cancer deaths

CHAPTER II

REVIEW OF THE LITERATURE

This literature review explores the impact of colorectal cancer on the general population and includes studies pertaining to histology among colorectal cancer patients. The former component of the review focuses on the differences in survival among various ethnic groups. The known risk factors of colorectal cancer, diet, age, physical inactivity, genetic susceptibility and weight, are examined and included Appendix 1. Literature reviews on the geographic distributions of colorectal cancer and future projections of the colorectal cancer burden on the Texas population are also included in Appendix 1.

Disease Impact

According to the American Cancer Society, an estimated 93,800 new cases of colon cancer (43,400 men and 50,400 women) and 36,400 new cases of rectal cancer (20,200 men and 16,200 women) will be diagnosed in 2000. Colon cancer is expected to be responsible for about 47,700 deaths (23,100 men and 24,600 women) during 2000 (American Cancer Society, 2000). Colorectal cancer is a major public health problem in both North America and western Europe (Howe, 1992). Since colorectal cancers are known to develop slowly over a period of several years, this has established important implications for public health as well as other health services around the world. There

will be a need for more medical, nursing, and related staff to treat these patients; there will be a need for more hospitals and treatment facilities available, and this will be a major expense for the near future as well as a major logistical problem. The implications for planning cancer control activities will need to increase to help reduce the mortality burden that is otherwise likely to materialize (Pollock, 1999). Cancer costs this nation an estimated $107 billion annually in health care expenditures and lost productivity. Reducing cancer burden means addressing behavioral and environmental factors that increase cancer risk (CDC, 2000).

Descriptive Characteristics of Colorectal Cancer

SEER data for 1992-96 show the median age at diagnosis of colorectal cancer in the United States is 70 for men and 74 for women (comparable median ages at diagnosis for other cancers are 63 for breast in women and 69 for lung in men). The overall incidence of colorectal cancer is higher in men (53.0/100,000 in 1992-96) than in women (37.6/100,000), and this holds for all age groups. Total incidence rates are comparable for whites (43.9/100,000) and blacks (49.9/100,000). Rates are similar for white (52.8/100,000) and black (57.6/100,000) men, but slightly lower for white (37.1/100,000) women compared to black (44.5/100,000) women. Incidence rates among blacks have caught up with those in whites. Mortality rate are slightly higher in blacks than whites

for both men and women (Ries, 1999). Hispanic women in this country experience lower risk of developing and dying of cancers of the breast, colon and possibly lung than their Anglo counterparts (Newell, 1986). Puerto Ricans in general have extremely low mortality rate from colon cancer relative to non-Hispanic whites (Shai, 1986).

Histology/Location

Ninety percent to 95% of all large bowel cancers are adenocarcinomas, the remaining histologic types being squamous cell carcinomas, adenosquamous carcinomas, lymphomas, sarcomas, and carcinoid tumors (Kessler, 1999). Studies have attempted to define the anatomic distribution of colorectal cancer in some black and white groups of the U.S. (Chattar-Cora, 1998). One study explored time trends over a 22-year period of the incidence of adenocarcinoma of the colon and rectum at various subsites among patients of different race, gender, and stage of disease. Findings indicated widely differing disease patterns based on anatomic subsite and patient demography and also indicated a need for targeted efforts at early detection of adenocarcinoma of the right colon among African Americans (Demers, 1997). Carcinoids of both the colon and rectum are more prevalent in blacks than in whites of both sexes (Thomas, 1995). About 70% of these tumors arise in the rectosigmoid colon. Right-sided lesions often are seen late in the course of development and therefore have a poorer prognosis than those of the left rectosigmoid (Newland, 1995). About 20% of adenocarcinomas are poorly

differentiated or undifferentiated and are associated with a poorer diagnosis. Forty-five percent of colorectal carcinomas are localized in the rectum, about 30% in the sigmoid colon, 15% in the right or transverse colon, and about 10% in the descending colon (Kessler, 1999).

Survival

The overall 5-year relative survival rate for all cancer sites combined among whites increased from under 40 percent in the early 1960s to more than 55 percent in the mid to late 1980s. For nearly every cancer site, there has been an improvement in survival (Harras, 1996). The 5-year relative survival among blacks is only 51.7 percent compared to 61.8 percent among whites diagnosed in 1989-95. Overall survival rates may obscure the survival differentials by individual primary site. Whites survive more than 10 percent points higher than blacks for cancer of the breast, cervix uteri, colon/rectum, corpus uteri, larynx, melanoma, oral cavity and pharynx, prostate, and urinary bladder. Differences in stage at diagnosis may account for some of these disparities, but other factors may have a role (Harras, 1996).

There has been a progressive improvement in survival from colorectal cancer over the past 20 years. In 1973, the relative survival rate was 45.6%, whereas the rate in 1986 was 61.5%, probably due to improvements in surgical technique, adjuvant chemotherapy, radiotherapy, and early detection (Sandler, 1996). Despite the overall improvement in survival for colon cancer, there is still evidence of racial disparity which appears to be increasing (Weaver, 1989). African Americans and Hispanics have lower survival rates

for colon cancer than Caucasian, possibly due to more advanced states of disease at diagnosis and to socioeconomic differences between the groups (Mayberry, 1995). Even though survival rates have increased for a few cancers among blacks, the overall survival rate for all cancers combined has increased only slightly since the mid 1970s. Americans have a one in twenty lifetime risk of developing this disease and approximately one in ten has a family member who develops colon cancer (Thun, 1991). The black/white difference in colon cancer survival has been well documented, but few studies have investigated colon cancer in Hispanics (Chattar-Cora, 1998). Black patients with colon cancer were found to have a poorer survival that white patients (Dayal, 1987). Blacks have much poorer 5-year survival rates than whites for carcinomas of the small intestine, colon, rectum, and anus. The much poorer survival of blacks versus whites for colorectal cancers correlates with black's later stage of presentation (Thomas, 1995). One study found about a 30% difference in survival between black and white colon cancer patients after adjusting for stage, age, sex, and SES (Dayal, 1987). However, other studies found that differences in anatomical subsite were unlikely to contribute to the poorer survival commonly observed among blacks (Coates, 1995 and Devesa, 1993). One study examined the aggressiveness of colon tumors in blacks and whites to explore its role in the racial survival differences. The findings from this study suggests that there may be racial differences in environmental exposure and that the intensity and mode of delivery of carcinogen in-situ as well as host susceptibility may differ by race and anatomical subsite (Chen, 1997).

CHAPTER III

METHODS

Data Sources

The Texas Department of Health's Cancer Registry and Bureau of Vital Statistics provided linked colorectal cancer data for this study. The functions of the Cancer Registry Division (CRD) involve collecting, analyzing, and disseminating information on the occurrence of cancer cases in Texas. The CRD maintains the Texas Cancer Registry (TCR), a population-based, state-wide database of cancer incidence reports, which collects all incident reports of neoplasms occurring among state residents, including certain benign tumors and borderline malignancies.

The primary sources of case reporting for the TCR are received from cancer registries of Texas hospitals, cancer registries of cancer treatment centers, outpatient clinics, and free-standing pathology labs. In addition, the TCR seeks information for those Texas residents who are diagnosed and treated outside of Texas. Incident cancer data are reported to the TCR in accordance with the Texas Cancer Incidence Reporting Act (Chapter 82, Health and Safety Codes). The primary sources of case reporting are responsible for submitting hard copies or computerized data for all cancer incident cases to the mini-registries. The standard data items requested on hard copies of confidential cancer incidence forms or in electronic format are reported to the five regional mini-registries located throughout the eleven public health regions in Texas. All reports of

cancer cases received from the regional mini-registries are then reported to the TCR central office, located in Austin, TX, within six months of initial diagnosis or admission to a diagnosis facility or cancer treatment.

The Texas Bureau of Vital Statistics maintains all records of births, deaths, marriages and divorces in Texas. To identify any cancer cases not reported to the TCR, death certificates maintained by the Bureau provide underlying causes of death due to malignant neoplasms. Missed cases not identified from any institution are added to the TCR database.

The mortality data used in this study were abstracted from death certificates and confidential cancer reporting forms containing information indicated in patient medical records and pathology reports. Linked data from the TCR and Bureau of Vital Statistics were obtained by matching colorectal cancer case information from the TCR against the Bureau of Vital Statistics mortality database. Variables from the TCR and Bureau of Vital Statistics were matched on each case's name, social security number, date of birth, sex, race/ethnicity, and address (including city, county, and zip code). Primary site and histologic type were coded for each cancer incident case using the International Classification of Disease for Oncology, version 2 (ICD-O-2) and causes of deaths were coded using the International Classification of Disease, version 9 (ICD-9). The ICD-O-2 and ICD-9 codes corresponding to each primary site category in this report are presented in the Appendix 2 and Appendix 3 respectively.

Matching Criteria

Variables from the Texas Cancer Registry and Bureau of Vital Statistics were matched using a probabilistic software known as "AutoMatch". Initially, record linkage methodology and software were developed at the U.S. Bureau of Census during the past several years primarily to support census coverage (Jaro, 1989). "AutoMatch" makes it feasible and efficient to link large public health databases in a statistically justifiable manner. Data from both entities were linked in three matching phases (Phase 1, Phase 2, and Phase 3).

In Phase 1, files were organized by social security number. For those individuals with an exact match on social security number, the last name, first name, date-of-birth, street address, county, sex, and race were compared. All files did not have to match exactly, but needed to have sufficiently similar information to be assigned a high score by the software, indicating a high probability that they were the same person. Files were manually reviewed and diagnosis date to date of death were compared to make sure that the date of death did not occur prior to diagnosis (which would require further investigation). The matches in Phase 1 were only for those people with identical social security numbers.

In Phase 2, files were organized by date of birth, last name, and first name. For those individuals with exactly the same date of birth, exactly the same last name, and exactly the same first name, the social security number, street address, county, sex, and race were compared. This will find people with minor differences in social

security number (perhaps due to transposition of numbers or typographical errors). This also finds people that might have a missing social security number in one file, but a valid social security number in the other file. Most of the matching records are found in the first two phases.

Finally files in Phase 3 were organized using the first three characters of the last name and the first three characters of the first name. For those matching exactly on those two fields, the full last name, full first name, date of birth, social security number, street address, county, sex, and race were compared. This finds individuals whose social security number might be slightly different or missing, and the date of birth might be slightly different or missing, but have the same name and address. Files were organized using only the first three characters of each name for purposes of finding those individuals with slight variations in name spelling (Anne vs Ann, Johnny vs John, Gonzales vs Gonzalez). All possible matches were then manually reviewed for final determination.

Texas Public Health Regions

The Texas Cancer Registry consists of five regional mini-registries located in Austin (Region 7), Houston (Regions 5 and 6), San Antonio (Regions 8 and 11), Lubbock (Regions 1, 9, and 10), and Arlington (Regions 2, 3, and 4) that collects data from the 11 Texas Public Health Regions (See Figure 1).

Study Sample

The study sample consisted of African American, Hispanic, and Caucasian men and women diagnosed with colon cancer and enrolled in the Texas Cancer Registry data set in 1992. The race and ethnicity of each cancer patient enrolled in the TCR data set were classified according to the categories defined in the North American Association of Central Cancer Registries (NAACCR) coding manual. The NAACCR uses two categories to describe white: white of Spanish/Hispanic origin (which includes Mexican, Puerto Rican, Cuban, South or Central American, and other Spanish) and white, non-Spanish/non-Hispanic origin (Anglo). The other race/ethnic groups were classified as African Americans and Other Races combined (American Indians, Alaskan Native, Asia or Pacific Islanders).

The race/ethnic categories used in this report represents the African-American (non-Hispanic black), Hispanic (Spanish/Hispanic origin), Caucasian (Anglo or non-Hispanic white), and Other (other race/ethnic designations) groups. The Texas Cancer Registry and Texas Bureau of Vital Statistics provided the following study variables: county of residence, race, date of birth, gender, age at diagnosis, date of diagnosis, primary histology site, date of death, cause of death, and age at death.

Subject Eligibility

African American, Hispanic, and Caucasian men and women diagnosed with colon cancer and enrolled in the Texas Cancer Registry data set from January 1, 1992 to December 31, 1992 were included in this study. Coded death certificates ascertained from the Texas Bureau of Vital Statistics provided data on all deaths occurring between January 1, 1992 and December 31, 1997. There were 192,731 individual death certificate files from 1992-1997 obtained at the Texas Bureau of Vital Statistics available for analysis. The 1992 Texas Cancer Registry cohort consisted of 5,203 records representing reported cases of colorectal cancers. Of those, death records were found for 2,319 cases and included in the study.

Statistical Analysis

Data in this study were analyzed using SPSS version 10.0 statistical software package. A six-year analysis of the distribution of time to death was performed on 2,319 colorectal records maintained in the 1992 Texas Cancer Registry cohort. Demographic tabulations were generated for comparison analyses.

The Kaplan-Meier procedure was employed to estimate the probability of survival among deceased subjects in the cohort for a specified length of time. Cases for which the event of interest (death) did not occur during the six-year period were not included in the

study. Kaplan-Meier survival curves were used to evaluate the distribution of time to death among the deceased cases. Cumulative survival probability estimates were also generated by the Kaplan-Meier procedure. Death time for each subject was calculated as the number of months from the date of diagnosis to the date of death.

The log-rank test was used to statistically compare survival estimates across the deceased group. The log-rank was employed to evaluate the null hypothesis being tested, that no overall survival difference exist among deceased subjects. Hypotheses were tested using p-values of 0.05 or less for statistical significance.

CHAPTER IV

RESULTS

Demographic Data

Table 1 displays the demographic characteristics of the 5,203 subjects in the 1992 Texas Cancer Registry cohort diagnosed with colorectal cancer. Majority of the individuals diagnosed with colorectal cancer in 1992 were between 70 and 79 years of age (31.3%), Caucasian (77.1%), and female (50.8%). Table 2 displays the total number of existing cases and the number of deceased colorectal cancer cases by race/ethnicity for the 1992 cohort. Analysis of county of residence data, shown in Table 1, revealed that the majority of subjects in the cohort lived in the following counties: Harris (13.9%), Dallas (9.8%), Bexar (6.7%), Tarrant (5.7%), and Travis (3.1%).

Age at Diagnosis

The mean age at diagnosis for the entire cohort was 69.97 ± 13.61 years. Table 1 shows majority of the study subjects (n=1628) were diagnosed between the ages of 70 and 79. Most of the Caucasian males (n=645) and females (n=666) were diagnosed

between 70 and 79 years of age. Most of the African American males (n=83) were diagnosed between ages 60 and 69, whereas most African American females (n=100) were diagnosed between ages 70 and 79. Majority of the Hispanic males (n=75) and females (n=60) were diagnosed between 70 and 79 years of age.

Table 1: Demographic Characteristics of Study Subjects

VARIABLE	N	PERCENT
Gender		
Male	2559	49.2%
Female	2643	50.8%
Unknown	1	0
Total	5203	100%
Race/Ethnicity		
Caucasian	4013	77.1%
African American	636	12.2%
Hispanic	495	9.5%
Other	59	1.1%
Age		
≤ 39	139	2.7%
40-49	294	5.7%
50-59	569	10.9%
60-69	1255	24.1%
70-79	1628	31.3%
80-89	1080	20.8%
≥ 90	238	4.6%
County of Residence		
Harris	721	13.9%
Dallas	512	9.8%
Bexar	349	6.7%
Tarrant	298	5.7%
Travis	163	3.1%

Table 2: Existing Cases and Deaths for 1992 Cohort

RACE/ETHNICITY	Alive	Deceased	Total
Caucasian			
Male	1132	836	1968
Female	1150	894	2044
Unknown	0	1	1
African American			
Male	107	181	288
Female	175	173	348
Hispanic			
Male	150	119	269
Female	133	93	226
Other			
Male	22	12	34
Female	15	10	25
Total	2884	2319	5203

The mean age at diagnosis for Caucasian males was 68.57 ± 12.65 years (range 6-102) and Caucasian females was 73.07 ± 13.13 years (range 10-104). The mean age at diagnosis for African American males was 66.88 ± 14.14 years (range 21-97) and African American females was 68.88 ± 15.29 years (range 5-101). The mean age at diagnosis for Hispanic males was 65.33 ± 14.22 (range 26-105) and Hispanic females was 66.55 ± 15.70 (range 28-93) (Table 3).

Table 3: Mean Age at Diagnosis

Variable	Mean Age	Standard Deviation
Race/Gender		
Caucasian		
Males	68.57	12.65
Females	73.07	13.13
African American		
Males	66.88	14.14
Females	68.88	15.29
Hispanic		
Males	65.33	14.22
Females	66.55	15.70

*Statistics

Mean	69.17
Median	72.00
Standard Dev	13.61
Range	(1-105)
SEM	0.19

Characteristics of Deceased Subjects

The mean age at death for the entire cohort was 70.95 ± 13.30 years. The mean age at death for males was 69.06 ± 12.51 years and for females 72.81 ± 13.80 years. The mean age at death for Caucasian individuals was 71.91 ± 12.76 years, African Americans 68.86 ± 14.16 years, and Hispanics 67.18 ± 14.80 years, shown in Table 4.

Table 4: Characteristics of Deceased Subjects

Variable	Mean Age	Standard Deviation
Gender		
Male	69.06	12.51
Female	72.81	13.80
TOTAL	70.95	13.30
Race		
Caucasian	71.91	12.76
African American	68.86	14.16
Hispanic	67.18	14.80
TOTAL	70.95	13.30

The five most common colorectal cancer histology types found among deceased subjects were: adenocarcinoma, NOS (67.8%), neoplasm malignant, NOS (13.5%), carcinoma, NOS (5.6%), mucinous adenocarcinomas (3.7%), and mucin-producing adenocarcinomas (3.7%). The five most common site descriptions of those subjects diagnosed with cancer of the colon were: the large intestine (26.1%), sigmoid colon (25.4%), cecum (16.2%), ascending colon (14.3%), and transverse colon (6.4%).

Geographic analysis of deceased subjects shows that majority of the deceased resided in the following counties: Harris (14.9%), Dallas (9.4%), Bexar (6.7%), Tarrant (5.9%), and Jefferson (2.9%) (Table 5).

Table 5: Characteristics of Deceased Subjects

Characteristic	%
Common Histology	
Adenocarinoma	67.8
Neoplasm malignant	13.5
Carcinoma	5.6
Mucinous adeno	5.1
Mucin-producin	3.7
Common Sites	
Large intestine	26.1
Sigmoid colon	25.4
Cecum	16.2
Ascending colon	14.3
Transverse colon	6.4
Counties of Residence	
Harris	14.9
Dallas	9.4
Bexar	6.7
Tarrant	5.9
Jefferson	2.9

Results of Statistical Analysis

During a period of six years, 2,319 subjects diagnosed with colorectal cancer in 1992 died. Data analysis indicate the probability of surviving colorectal cancer less than six months after diagnosis was estimated to be 62.58%. The probability of surviving colorectal cancer twelve months after diagnosis was estimated to be 39.16%. The median survival time for the subjects was twelve months. The median survival time is the first observed time at which the cumulative survival is 50.0% or less (Table 6).

Table 6: Overall Distribution of Time to Death for Subjects

Time (months)	*PERCENT*
<6	62.58%
6-11	50.67%
12-17	39.16%
18-23	31.33%
24-29	24.02%
30-35	20.8%
36-41	18.54%
42-47	12.97%
48-53	9.04%
54-59	5.74%
60-65	2.44%
66-71	0.35%

	Survival Time	*SEM*	*95% CI*
Mean	15.43	0.52	14.42-16.44
Median	12.00	0.74	10.55-13.45

Hispanic females and Caucasian males had higher survival times among the race and gender groups. Less than six months after diagnosis, estimated survival times for Hispanic females were 65.59% and 65.52% for Caucasian males. African American males and females experienced lower survival times for the cohort. Less than six months after diagnosis, the estimated survival time for African American males was 53.85% and 56.40% for African American females. African American males experienced the lowest survival time for the cohort. All African American males were deceased by forty-eight months (year four) after diagnosis. All subjects were deceased by seventy-two months (year six) after diagnosis. Although Hispanic females had the highest probability of

surviving less than six months after diagnosis, they experienced the lowest distribution of time to death among females. All Hispanic females were deceased by forty-eight months (year four) after diagnosis. African American males experienced both the lowest survival times and distribution of time to death among the male group (Table 7).

Table 7: Distribution of Time to Death By Race and Gender

Time (months)	***Caucasian Males***	***African American Males***	***Hispanic Males***	***Caucasian Females***	***African American Females***	***Hispanic Females***
<6	62.52%	53.85%	62.71%	57.74%	56.40%	65.59%
6-11	52.47%	40.66%	52.54%	47.42%	47.09%	55.91%
12-23	40.50%	29.12%	44.92%	35.20%	35.47%	38.71%
24-35	25.07%	13.74%	32.20%	19.17%	24.42%	21.51%
36-47	14.34%	6.04%	15.25%	9.75%	12.79%	10.75%
48-59	6.81%	1.10%	5.93%	3.92%	6.98%	6.45%
60-71	0.36%	0.0%	0.85%	0.56%	1.16%	0.0%
72-77	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

In comparing the survival functions across the ethnic groups, a pair-wise log-rank test was employed. One of the objectives being explored in the study was whether differences in ethnicity affect the time to death among colorectal cancer patients. The plot of the estimated survival times for each ethnic and gender group is shown in Figures 2 and 3. These figures show that African American men and women had the lowest estimated survival time. Results from the pair-wise log-rank statistical analysis, shown in

Table 8, yielded that there is a significant difference in survival among African American and Caucasian males (p-value= 0.0000) and African American and Hispanic males (p-value = 0.0001). P-values were less than 0.05, and the null hypothesis is rejected. Among females, there is no significant difference in survival between ethnic groups. The survival curves were not adjusted.

Table 8: Pair-wise Log Rank of Gender by Race

GENDER	RACE/ETHNICITY	COMPARISON GROUP	
		Caucasian	African American
Males	African American	19.32 (0.0000)	X
	Hispanic	0.72 (0.3968)	14.83 (0.0001)
Females	African American	1.29 (0.2553)	X
	Hispanic	0.74 (0.3884)	0.00 (0.9813)

Another objective explored in this study was to determine what histologic characteristic might contribute to the ethnic and gender differences in colorectal cancer deaths. The plot of estimated survival times for each histology type is shown in Figure 4. Those individuals diagnosed with neoplasm malignant tumors had the lowest survival estimates. The probability of surviving with neoplasm malignant tumors less than six months after diagnosis was 11.15%. Individuals diagnosed with mucin producing

adenocarcinomas had the highest survival estimates (74.71%) less than six months after diagnosis. However, the distribution of time to death for all histology types were the same for each type. All individuals who were diagnosed with these histology types were deceased by sixty months (year five) (Table 9).

Table 9: Distribution of Time to Death by Histology

Time (months)	Adenocarcinoma	Mucin Producing	Neoplasm malignant	Carcinoma	Mucinous adeno
<6	70.56%	74.71%	11.15%	31.01%	72.27%
6-11	57.65%	59.65%	10.51%	20.93%	57.98%
12-23	43.77%	44.83%	9.87%	13.95%	37.82%
24-35	25.11%	27.59%	7.64%	9.30%	20.17%
36-47	13.23%	10.34%	4.78%	5.43%	9.24%
48-59	5.55%	3.45%	2.87%	1.55%	5.04%
60-71	0.0%	0.0%	0.0%	0.0%	0.0%
72-77	0.0%	0.0%	0.0%	0.0%	0.0%

In comparing the survival functions across the histology groups, a pair-wise log-rank test was employed. The plot of the estimated survival times for each histology type by race is shown in Figures 5, 6 and 7. These figures show that neoplasm malignant tumors had the lowest estimated survival time for all races, expect Hispanics. Hispanics who were diagnosed with carcinomas had the lower estimated survival times than those diagnosed with neoplasm malignant tumors. Results from the pair-wise log-rank statistical analysis, shown in Table 10, yielded that there is a significant difference in survival among African Americans and Caucasians (p-value= 0.0059) diagnosed with

mucinous adenocarcinomas and African Americans and Hispanics (p-value = 0.0426) diagnosed with malignant neoplasms. P-values were less than 0.05, and the null hypothesis is rejected. The survival curves were not adjusted.

Table 10: Pair-wise Log Rank of Histology by Race

HISTOLOGY	RACE/ETHNICITY	COMPARISON GROUP	
		Caucasian	African American
Adenocarcinoma	African American	3.56 (0.0590)	X
	Hispanic	0.28 (0.5955)	2.68 (0.1019)
Mucin Producing Adenocarcinoma	African American	0.51 (0.4771)	X
	Hispanic	3.87 (0.0510)	1.15 (0.2835)
Malignant Neoplasms, NOS	African American	0.22 (0.6428)	X
	Hispanic	2.82 (0.0931)	4.11 (0.0426)
Carcinoma	African American	0.00 (0.9492)	X
	Hispanic	3.02 (0.0821)	1.72 (0.1891)
Mucinous Adenocarcinoma	African American	7.57 (0.0059)	X
	Hispanic	0.06 (0.7994)	2.02 (0.1552)

The plot of the estimated survival times for each histology type by gender is shown in Figures 8 and 9. These figures show that neoplasm malignant tumors had the lowest estimated survival time for both genders. Results from the pair-wise log-rank statistical analysis, shown in Table 11, yielded that there is a significant difference in survival among males and females (p-value= 0.0176) diagnosed with mucin producing adenocarcinomas.

Table 11: Pair-wise Log Rank of Histology by Gender

HISTOLOGY	GENDER	COMPARISON GROUP
		Females
Adenocarcinoma	Males	2.29 (0.1305)
Mucin Producing Adenocarcinoma	Males	5.63 (0.0176)
Malignant Neoplasms, NOS	Males	0.19 (0.6659)
Carcinoma	Males	0.23 (0.6340)
Mucinous Adenocarcinoma	Males	2.56 (0.1099)

CHAPTER V

DISCUSSION

National cancer statistics compiled from SEER data (1973-1996) indicates African Americans experience lower rates of survival from colorectal cancer among the race/ethnic groups and males experience lower rates of survival from colorectal cancer among the genders (Reis, 1999). Other studies, (Weaver, 1989), have indicated that racial disparities exist among survival from colorectal cancer. A report published by the Texas Department of Health, (Carozza, 1999), illustrated that the cancer experience of Texas residents differed substantially by race/ethnicity. Among all races, colorectal cancer was the third leading cause of death in Texas for both males and females. This study is the first to compare the distribution of time to death among colorectal cancer patients in the state of Texas.

For the deceased subjects diagnosed with colorectal cancer in 1992, survival time estimates after six years of diagnosis were higher among Caucasian males and Hispanic females. Although Hispanic females had the highest probability of surviving less than six months after diagnosis, they experienced the lowest distribution of time to death among females. All Hispanic females were deceased by forty-eight months (year four) after diagnosis. African American males experienced both the lowest survival times and distribution of time to death among the male group. The actual point of tumor initiation

cannot be determined from the date of diagnosis. Therefore, some subjects may have had colorectal cancer for a period of time prior to actual diagnosis. This is known as "lead-time", and properties of "lead-time" may introduce some bias in the survival time calculations and evaluation of time to death distributions.

Histology analysis indicate that survival among those who died from malignant neoplasms were 11.15% less than six months after diagnosis. Individuals diagnosed with mucin producing adenocarcinomas had the highest survival estimates (74.71%) less than six months after diagnosis. However, the distribution of time to death for all histology types were the same for each type. All individuals who were diagnosed with the common histology types, adenocarcinomas, neoplasm malignant tumors, carcinomas, mucinous adenocarcinomas, and mucin producing adenocarcinomas, were deceased by sixty months after diagnosis.

One limitation of this study was that stage of diagnosis was not available for the cohort. Stage of diagnosis is an evaluation of tumor size, lymph node involvement and metastasis. Stage can be an important predictor of survival for colorectal cancer patients. According to Thomas and et al., greater than 70% of carcinoid tumors have either regional or distant metastases at the time of diagnosis. Carcinoid tumors with regional metastases are associated with a 5-year survival rate of 34%, much lower than that for adenocarcinomas (60%). Tumors with distant metastases are associated with a much higher survival rate (23%) than carcinomas (6%). Without stage information, the relationship between stage at diagnosis and time to death distributions could not be determined.

Linked or matched data were obtained from the Texas Cancer Registry and Bureau of Vital Statistics. The Texas Cancer Registry is a population-based registry, which contains large numbers of cases and the resources to conduct distribution analyses. The aspect of having the Texas Cancer Registry as the primary data source in this study contributes to the strengths of the study. However, lack of information pertaining to stage of diagnosis and treatment information were not available and contributes to the limitations of the study. Significant information on the known risk factors of colorectal cancer, diet, physical inactivity, genetic susceptibility and weight, were not ascertained from the cohort. Therefore, risk factors for colorectal cancer were not evaluated in the study.

Despite the limitations of the data, a significant difference in survival time estimates among deceased subjects was found among African American males and their male counterparts. There was no difference in survival time among deceased females. Individuals with neoplasm malignant tumors had the lowest estimated survival time among the races, expect Hispanics. Hispanics who were diagnosed with carcinomas had lower estimated survival times than those individuals diagnosed with neoplasm malignant tumors. For overall distribution of time to death among deceased subjects, African American males and Hispanic females experienced the lowest distribution times among the subjects. The overall distribution of time to death for all histology types were the same for each type.

There are several noteworthy applications for this type of study. This type of study is useful in examining the effects of colorectal cancer in population subgroups. It can be utilized to obtain information on colorectal cancer disease patterns over a specified time and associate such patterns to the distribution of time to death among patients diagnosed with colorectal cancer. As a result of the presented findings, this study has explored the distribution of colorectal cancer death times among men and women and various ethnic groups. A study of this nature can be applied to public health practice by identifying factors essential to cancer control interventions, such as screening and early detection treatments, among population subgroups defined by geographic and demographic characteristics.

APPENDICES

Appendix 1: Colorectal Cancer Risk Factors Literature Review

Diet

Differences in colon carcinoma have been postulated to be related to fiber in the diet. Therefore, cultural differences can affect diet and in turn play a part in cancer epidemiology. Although the cause of colorectal cancer is not known, deficient dietary fiber has been suggested as a factor (Newland, 1995). A diet that consists mostly of foods that are high in fat, especially from animal sources, can increase the risk of colorectal cancer (American Cancer Society, 2000). Animal experiments have shown dietary fat to promote large bowel tumors (Reddy, 1983). Epidemiologic studies have generally shown a direct association between fat intake and colorectal cancer risk. In a prospective cohort study of approximately 90,000 nurses, investigators found that women in the highest of five categories of daily animal fat intake, compared to those in the lowest category, had nearly twice the risk of developing colon cancer (Willett, 1990). In a recently reported investigation of male health professionals with adenomatous polyps, men in the highest category of dietary fat intake had twice the risk of adenomatous polyps as those in the lowest quintile (Giovannucci, 1990). The large majority of case-control studies of colorectal cancer that assessed vegetable intake found it to be protective (Potter, 1993). Several case-control studies of large bowel cancer have shown an inverse association for fruit intake, but in general the analytic epidemiologic findings are not consistent for fruit as for vegetables (Slattery, 1988). Because vegetables are a major source of dietary fiber in industrialized countries, the observed protective association for vegetables might be due to fiber or the joint effect of fiber and specific

anticarcinogens found in vegetables (Glynn and Albanes, 1994). A meta-analysis of 16 case-control studies found nearly a 35% reduction in the relative risk of colorectal cancer for those in the highest, compared to the lowest, category of dietary fiber intake (Trock, 1990). However, the most recent study to examine the relation between fiber intake and the risk of colorectal cancer in a large cohort of women found no evidence that total vegetable-fruit fiber intake is protective against colorectal cancer or adenoma (Fuchs, 1999).

Age

The incidence of colorectal cancer, as with many malignancies, is extremely low in childhood, increasing dramatically with age (Ries, 1999). Colorectal cancer is most common in men and women aged 50 years and older and the risk increases with age (National Cancer Institute, 2000). About 90% of people found to have colorectal cancer are older than 50 (American Cancer Society, 2000).

Physical Inactivity

An association between low physical activity and large bowel malignancy has become one of the most consistent epidemiologic findings for this disease in recent years. Well over a dozen studies, both case-control and cohort, employing several different methods of physical activity assessment, have demonstrated this association (Lee, 1991). One study identified colon cancer being 60% to 80% higher in sedentary workers of Los Angeles County compared with occupations requiring greater physical activity

(Garabrant, 1984). Colon cancer among 1.1 million Swedish men was similarly low in active men (Gerhardsson, 1986). Agricultural, forestry, and sawmill workers were at reduced risk for colon cancer when compared with sedentary workers (Fredriksson, 1989). These studies present a compelling argument that exercise may have a protective role in risk abatement of certain cancers, namely colon (Vena, 1987).

Genetic Susceptibility

A positive family history for colorectal cancer remains an important risk factor for colorectal carcinoma. Individuals with a single first-degree relative with colorectal cancer have about a twofold risk of themselves developing this cancer. When more relatives are affected, the risk is even higher (Sandler, 1996). Analyses of kindreds in Utah have been interpreted to indicate a dominant pattern of inheritance for susceptibility to adenomatous polyposis and colorectal cancer (Cannon-Albright, 1988). Investigators have identified mutated genes involved in the development of familial adenomatous polyposis (FAP) (Groden, 1991), a rare inherited condition that is characterized by many hundreds of large intestinal polyps and progresses to cancer with very high frequency, and hereditary nonpolyposis colon cancer (HNPCC) (Leach, 1993), a familial syndrome in which affected individuals develop tumors in the colon (and other organs) often before 50 years of age.

Weight

Being very overweight increases a person's colorectal cancer risk. Having excess fat in the waist area increases this risk more than having the same amount of fat in the thighs or hips. Researchers suggest that the excess fat changes metabolism in a way that increases growth of cells in the colon and rectum, and that fat cells in the waist area have the largest impact on metabolism (American Cancer Society, 2000). Epidemiologic studies have found a small direct assocation between obesity and risk of large bowel malignancy (Wu, 1987).

Geography

Rates of colorectal cancer vary considerably with geography. This disease is common in the United States, Western Europe, Scandinavia, Australia, and New Zealand and is relatively uncommon in Asia, Africa, and South America (Sandler, 1996). with most cancer, the rate of colorectal cancer differs in different parts of the world. Citizens of Connecticut have 10 times as much colorectal cancer as do the people of Bombay, India (Higginson, 1992). Men of the Czech republic are at least 15 times more likely to die of cancer of the colon and rectum than men of Albania (Landis, 1998). In general, people who live in the less developed countries of Africa and Asia have a lower frequency of this cancer than people who live in more highly developed North American

and northern Europe (Trichopoulous, 1997). Similarly, people who live in the northeast part of the United States are more vulnerable to cancer of the large intestine than other Americans (Pickle, 1987). Little, if any research has looked at the regional distribution of colorectal cancer in an American Hispanics (Chattar-Cora, 1998).

Characteristics of Texas' Population

The size and diversity of Texas' geography have a direct impact on the availability of cancer diagnosis, treatment, and prevention. Cancer is currently the second-leading cause of death in the state of Texas. The proportion of cancer deaths to all deaths in Texas has been increasing steadily for the past half-century. Epidemiologists project that in the early part of the 21st century, cancer will overtake heart disease as the leading cause of death (Texas Cancer Data Center, 2000). In Texas, as in the nation, the growing numbers of older adults will increase the number of people affected by cancer. About 35,600 Texans are projected to die from cancer in 1998. The number of Texans diagnosed with cancer is increasing, primarily due to the aging of the population and the more widespread use of cancer screening tests. Texas' population is projected to increase by 5.5 percent between 1998 and 2003. By the year 2003, Texas' Hispanic population is projected to increase by 12.0 percent, African Americans (Blacks) by 5.3 percent, and Whites by 1.5 percent. Forty percent of Texans with cancer now live at least five years after diagnosis. African-American Texans have the highest rates of mortality for lung, breast, prostate, colon, and cervical cancers. The five-year survival rate for African Americans also is lower. Nationally, the five-year survival for African Americans

diagnosed from 1989 through 1993 was 44 percent, compared to 60 percent for Whites. The large difference in survival is attributed to later diagnosis of cancer among African Americans. The experiences of African-American Texans are believed to be comparable to those nationally. Except for cervical, liver, and gallbladder cancer, Hispanics in Texas, to date, have lower cancer mortality rates than Whites or African Americans. Information regarding Asian American and Native American subpopulations in Texas is not available (Texas Cancer Data Center, 2000).

Appendix 2: SEER Site Recode for ICD-O-2 Incidence Data

Site Description	Site	Types
Digestive System		
Esophagus	C150-C159	(Exc Types 9590-9989)
Stomach	C160-C169	(Exc Types 9590-9989)
Small Intestine	C170-C179	(Exc Types 9590-9989)
Colon exc. Rectum		
Cecum	C180	(Exc Types 9590-9989)
Appendix	C181	(Exc Types 9590-9989)
Ascending colon	C182	(Exc Types 9590-9989)
Hepatic flexure	C183	(Exc Types 9590-9989)
Transverse colon	C184	(Exc Types 9590-9989)
Splenic flexure	C185	(Exc Types 9590-9989)
Descending colon	C186	(Exc Types 9590-9989)
Sigmoid colon	C187	(Exc Types 9590-9989)
Large intestine, NOS	C188-C189, C260	(Exc Types 9590-9989)
Rectum and rectosigmoid		
Rectosigmoid junction	C199	(Exc Types 9590-9989)
Rectum	C209	(Exc Types 9590-9989)
Anus, anal canal and anorectum	C210-C212,C218	(Exc Types 9590-9989)
Liver	C220	(Exc Types 9590-9989)
Intrahepatic bile ducts	C221	(Exc Types 9590-9989)
Gallbladder	C239	(Exc Types 9590-9989)
Other biliary	C240-C249	(Exc Types 9590-9989)
Pancreas	C250-C259	(Exc Types 9590-9989)
Retroperitoneum	C480	(Exc Types 9590-9989)
Peritoneum, omentum and mesentery	C481-C482	(Exc Types 9590-9989)
Other digestive organs	C268-C269,C488	(Exc Types 9590-9989)

Appendix 3: Ninth Revision ICD Mortality Categories

Primary Site Category	ICD-9 Code
Oral Cavity, Pharynx	140.0-149.9
Esophagus	150.0-150.9
Stomach	151.0-151.9
Small Intestine	152.0-152.9
Colon	153.0-153.9, 159.0
Rectum	154.0-154.1
Anus	154.2-154.3, 154.8
Liver, Intrahepatic Bile Duct	155.0-155.2
Gallbladder, Other Biliary	156.0-156.9
Pancreas	157.0-157.9
Retroperitoneum, Peritoneum	158.0-158.9
Other Digestive	159.8-159.9
Nasal Cavity, Sinuses, Ear	160.0-160.9
Larynx	161.0-161.9
Lung, Bronchus	162.2-162.9
Pleura	163.0-163.9
Trachea, Other Respiratory	162.0, 164.2-165.9
Bone	170.0-170.9
Connective, Soft Tissue	171.0-171.9, 164.1
Melanoma of Skin	172.0-172.9
Other Skin	173.0-173.9
Breast	174.0-174.9, 175._
Uterus, NOS	179._

Figure 1: Texas Public Health Regions

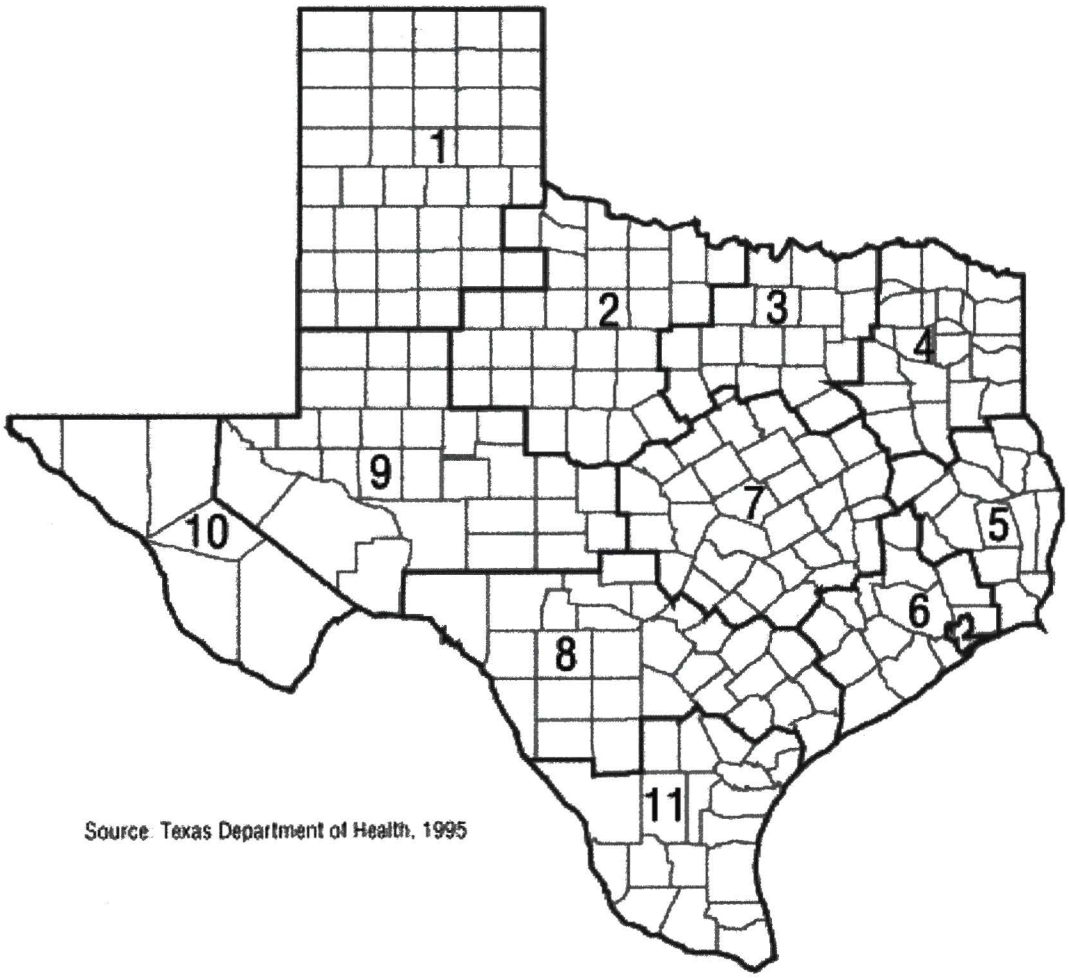


Figure 2: 1992 TCR Cohort Distribution of Time to Death by Gender

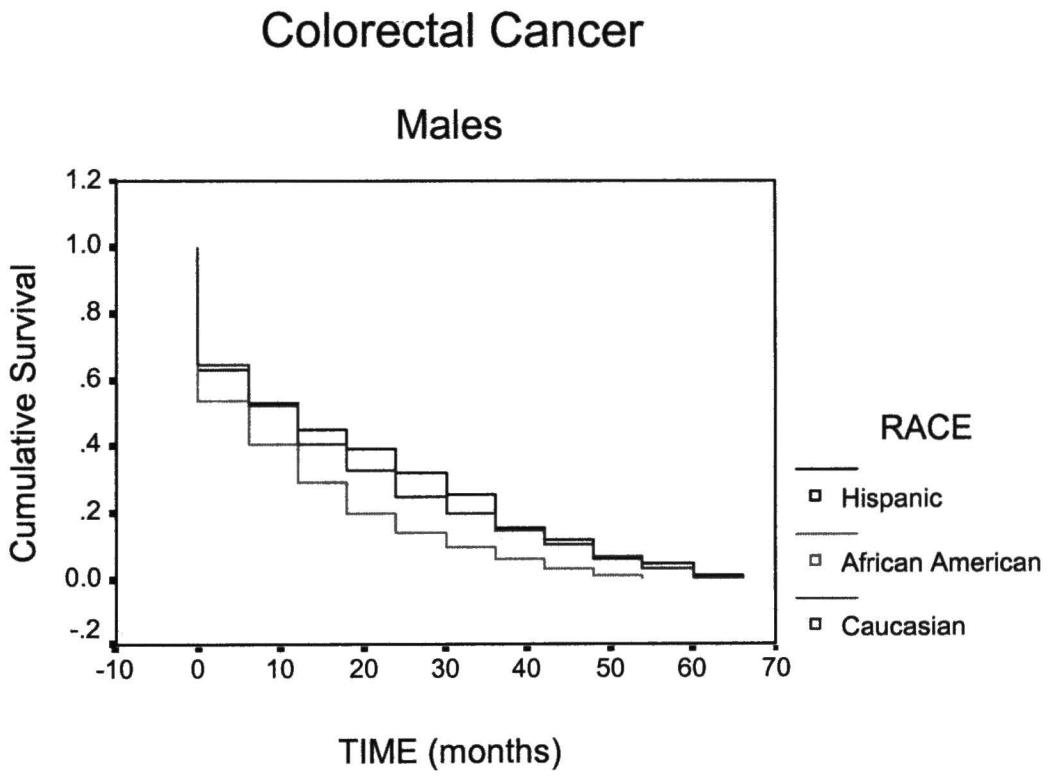


Figure 3: 1992 TCR Cohort Distribution of Time to Death by Gender

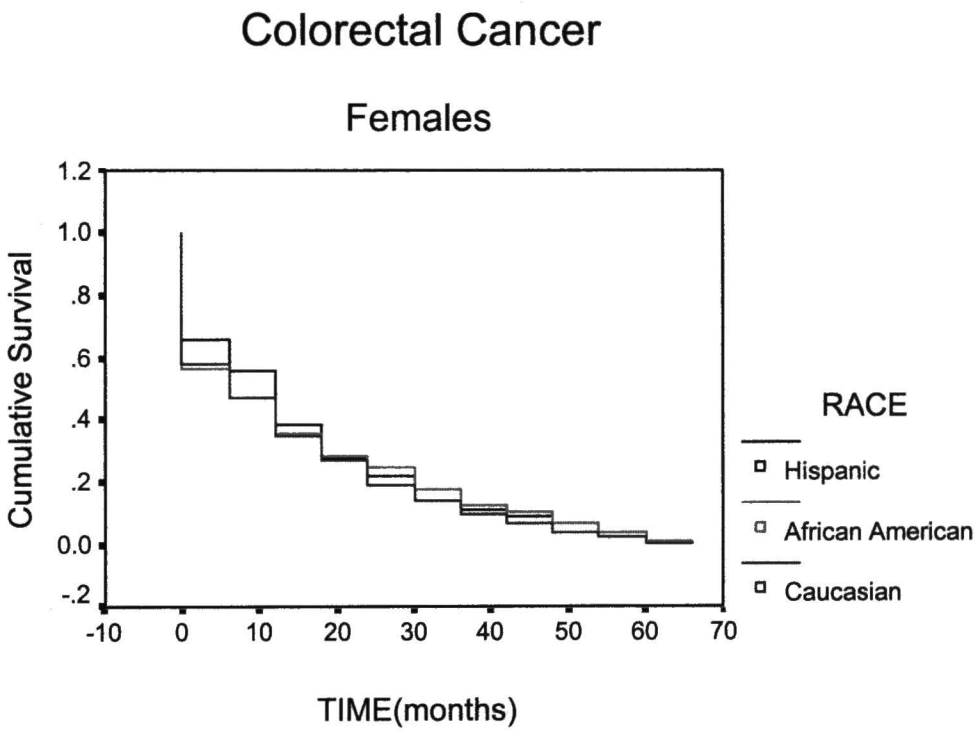


Figure 4: Distribution of Time to Death for Histology Groups

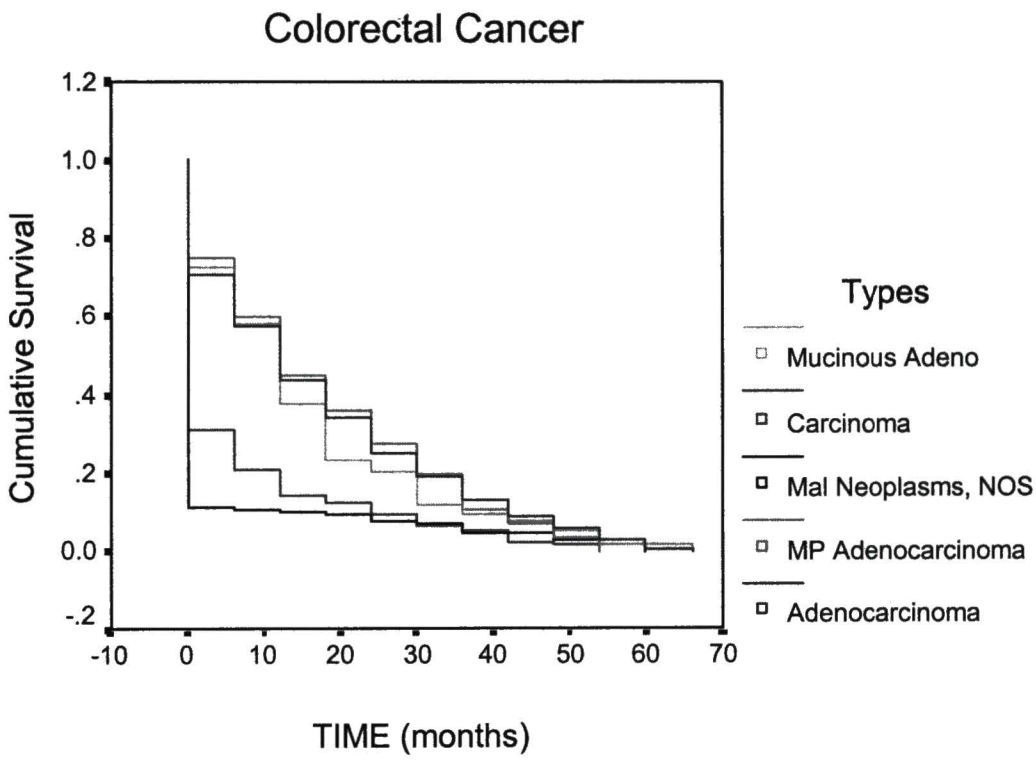


Figure 5: Distribution of Time to Death for Histology Types by Race

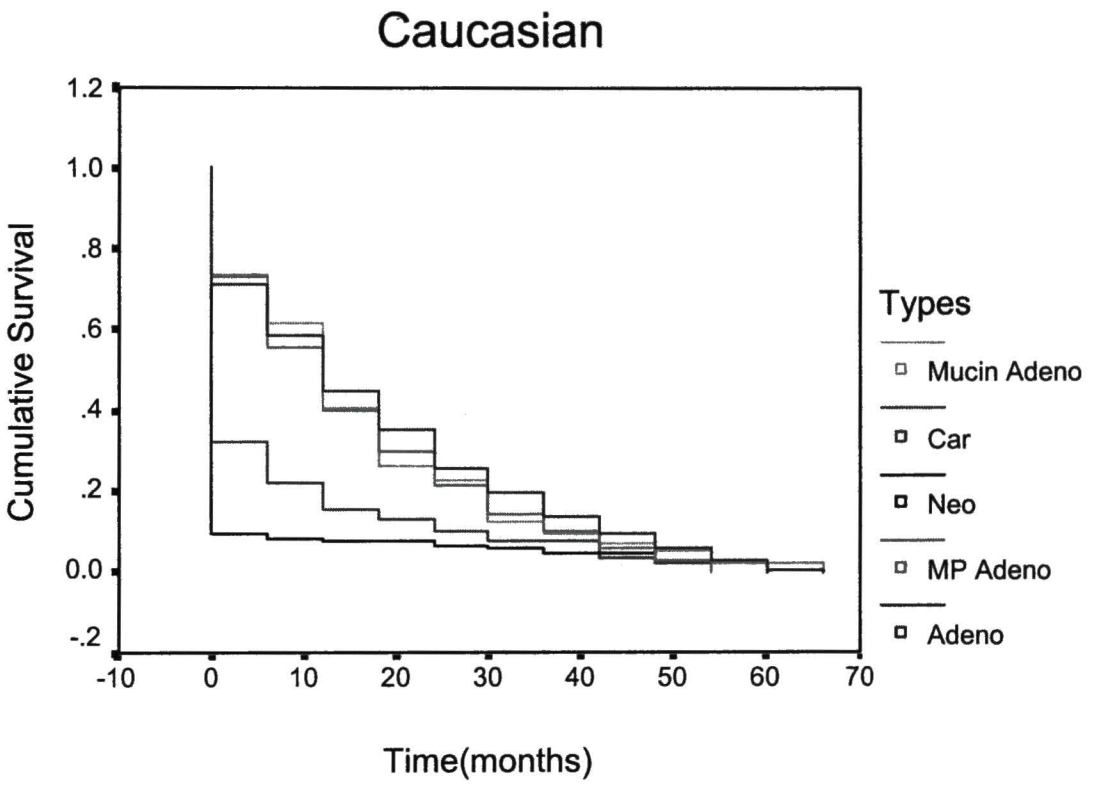


Figure 6: Distribution of Time to Death for Histology Types by Race

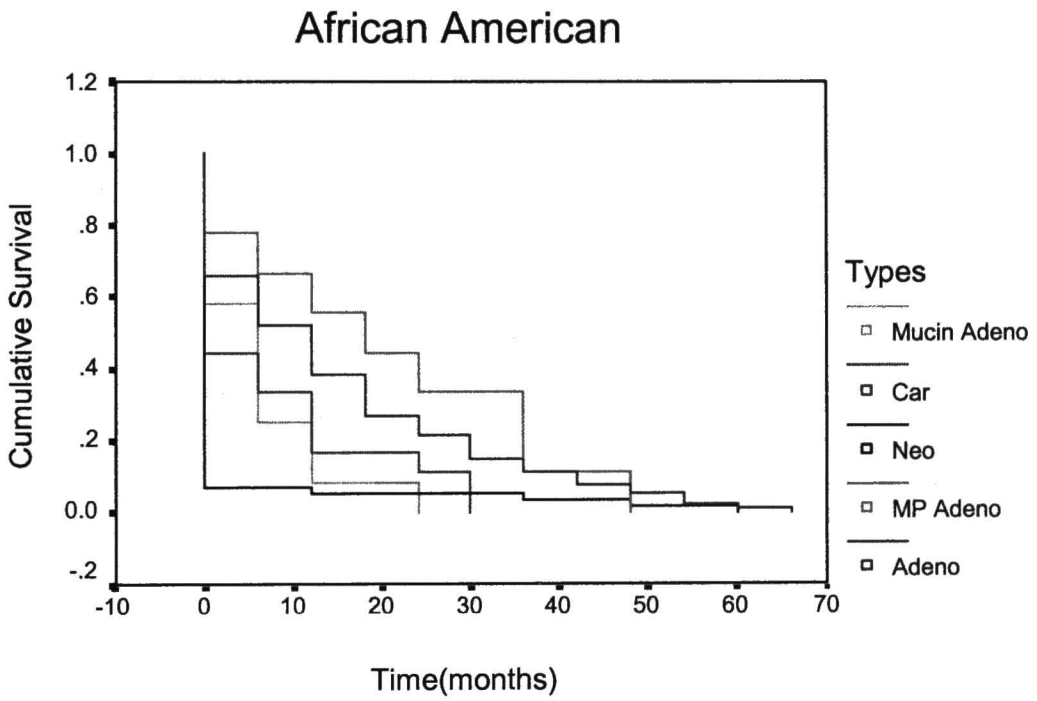


Figure 7: Distribution of Time to Death for Histology Types by Race

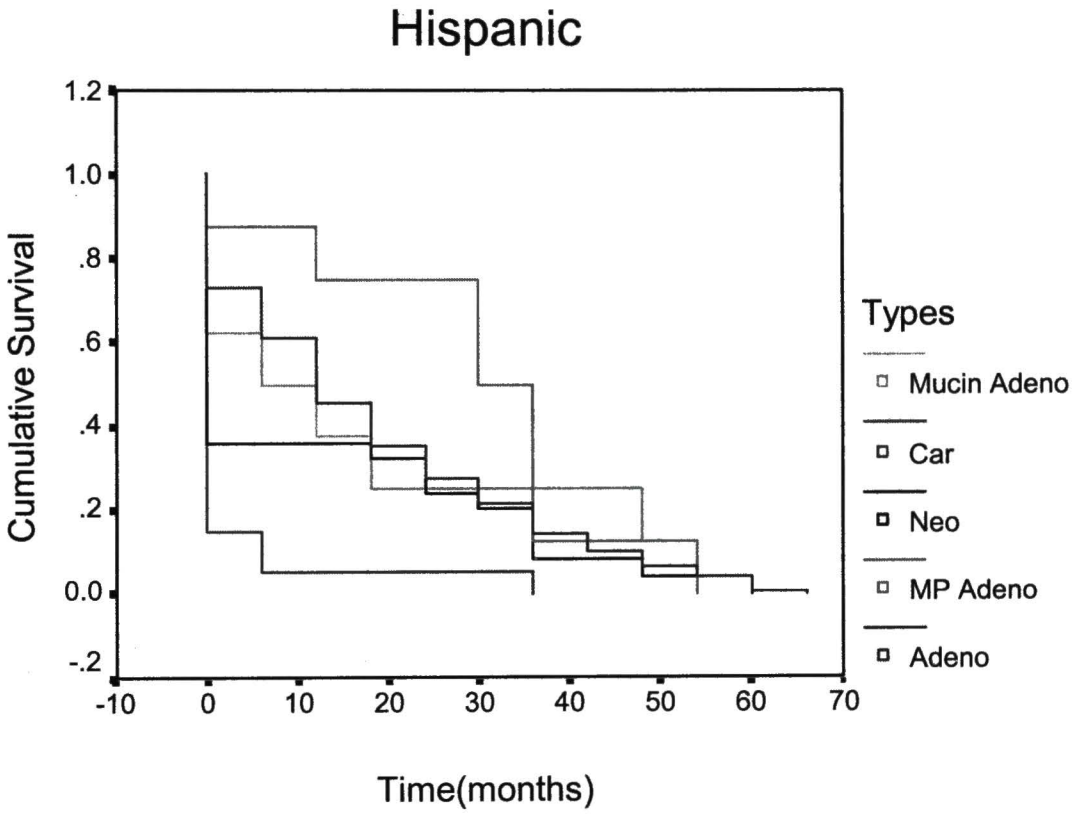


Figure 8: Distribution of Time to Death for Histology Types by Gender

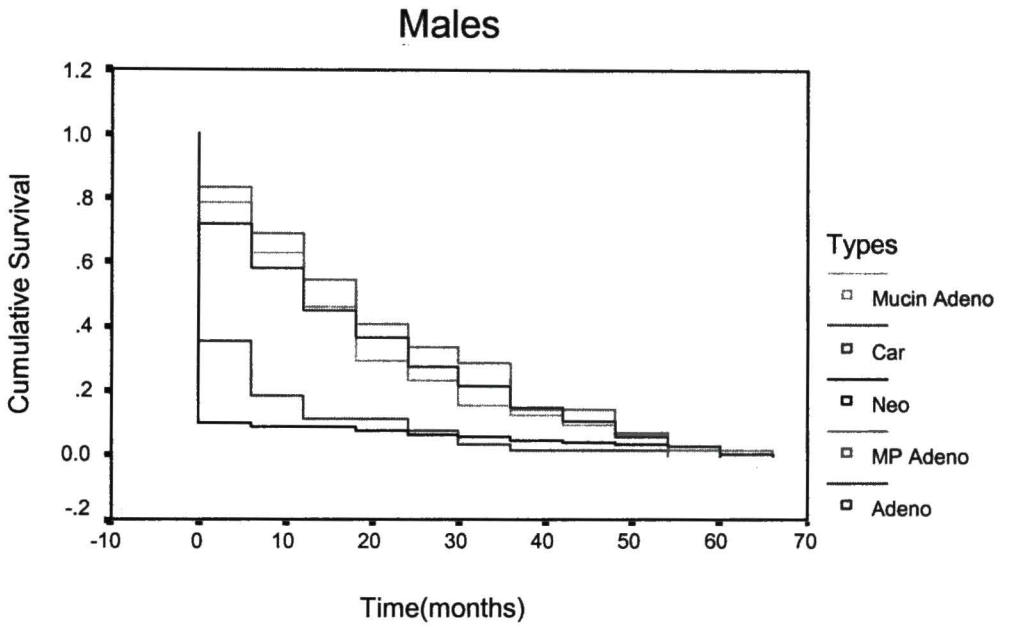
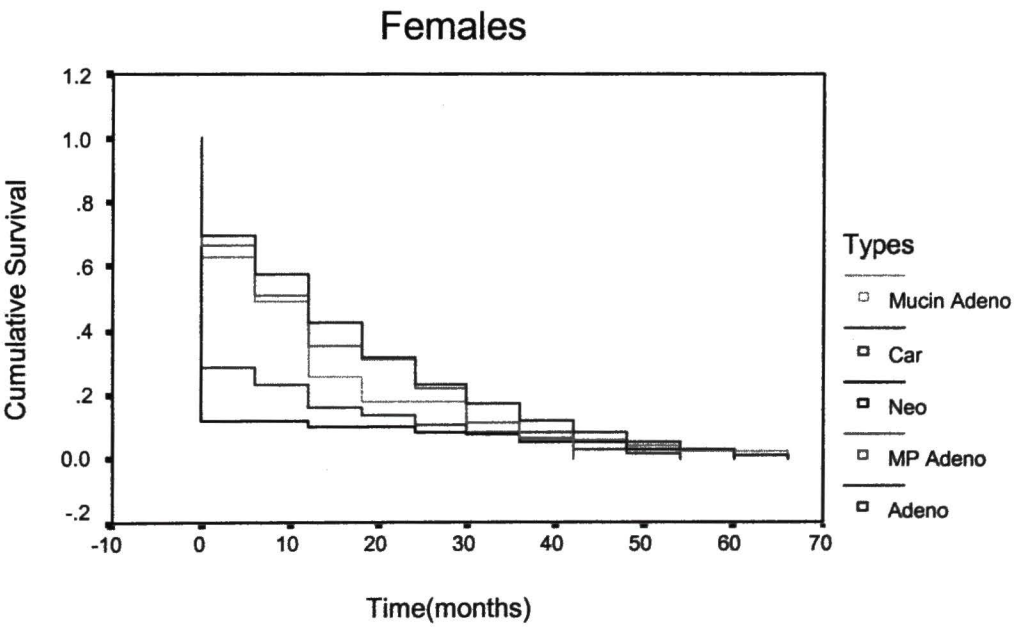


Figure 9: Distribution of Time to Death for Histology Types by Gender



REFERENCES

American Cancer Society, Inc. (2000). Colon and rectum cancer resource center [On-line]. Available: http:// www.cancer.org

Boyle, P. (1999). Cancer Epidemiology. In R.E. Pollock, J.H. Doroshow, J.G. Geraghty, et al (Eds.). Manual of Clinical Oncology. Canada: Wiley-Liss, Inc.

Cannon-Albright, L.A., Skolnick, M.H., Bishop, D.T., et al. (1988). Common inheritance of susceptibility to colonic adenomatous polyps and associated colorectal cancers. New England Journal of Medicine, 319 (9), 533-537.

Carozza, S.E., Risser, D.R., Weiss N.S. (1999). Cancer in Texas, 1995. Austin, TX: Texas Department of Health.

Centers for Disease Control and Prevention. (2000). Colon Cancer. National Center for Chronic Disease Prevention and Health Promotion. Available: http//: www.cdc.gov/nccdphp/major.htm

Chattar-Cora D. Onime GD. Valentine IS. Rivera-Cora L. (1998). The anatomic distribution of colorectal cancer in a New York City Puerto Rican group. Boletin - Asociacion Medica de Puerto Rico, 90 (7-12), 126-9.

Chen, V.W., Fenoglio-Presier, C.M., Wu, X.C., et al. (1997). Aggressiveness of colon carcinoma in blacks and whites. Cancer Epidemiology, Biomarkers, and Prevention, 6 (12), 1087-93.

Coates, R.J., Greenberg, R.S., Liu, M.T., et al. (1995). Anatomic site distribution of colon cancer by race and other colon risk factors, Distal Colon Rectum, 38 (1), 42-50.

Dayal, H., Polissar, L. Yang, C.Y., et al. (1987). Race, socioeconomic status, and other prognosis factors for survival from colorectal cancer, Journal of Chronic Disease, 40 (9), 857-64.

DeCosse, J.J. (1986). Cancer of the colon and rectum. In Holleb Al (ed.), The American Cancer Society Cancer Book – Prevention, Detection, Diagnosis, Treatment, Rehabilitation and Cure (pp. 347-61). New York: Doubleday and Company, Inc.

Demers, R.Y., Severson R.K., Schottenfeld D., et al. (1997). Incidence of colorectal adenocarcinoma by anatomic subsite. An epidemiologic study of time trends and racial differences in the Detroit, Michigan area. Cancer, 79 (3), 441-7.

Devesa, S.S., Chow, W.H. (1993). Variation in colorectal cancer incidence in the United States by subsite of origin, Cancer, 71 (12), 3819-3826.

Fredriksson, M., Bengtsson, N.O., Hardell, L., Axelson, O. (1989). Colon cancer, physical activity, and occupational exposures. Cancer, 63 (9), 1838-1842.

Fuchs, C.S., Giovannucci, E.L., Colditz, G.A., et al. (1999). Dietary fiber and the risk of colorectal cancer and adenoma in women, The New England Journal of Medicine, 340 (3), 169-176.

Garabrant, D.H., Peters, J.M., Mack, T.M., Bernstein, L. (1984). Job activity and colon cancer risk. American Journal of Epidemiology, 119 (6), 1005-1014.

Gerhardsson, M., Norell, S.E., Kiviranta, H., Pederson, N.L., Ahlbom, A. (1986). Sedentary jobs and colon cancer. American Journal of Epidemiology, 123 (5), 775-80.

Giovannucci, E., Stampfer, M.J., Colditz, G.A., et al. (1992). Relationship of diet to risk of colorectal adenoma in men. Journal of National Cancer Institute, 84 (2), 91-98.

Glynn, S.A., Albanes, D. (1994). Folate and cancer: A review of the literature. Nutrition and Cancer, 22, 101-19.

Groden, J., Thliveris, A., Samowitz, W., et al. (1991). Identification and characterization of the familial adenomatous polyposis coli gene. Cell, 66 (3), 589-600.

Harras, A., Edwards, B.K., Blot, W.J., et al. (Eds.) (1996). Cancer Rates and Risks. National Cancer Institute. (NIH Pub. No. 96-691). Bethesda, MD.

Higginson, J., Muir, C.S., Munoz, N. (1992). Human Cancer: Epidemiology and Environmental Causes. Cambridge: Cambridge University Press.

Howe, G.R., Benito, E., Castelleto, R., Cornee, J. et al. (1992). Dietary intake of fiber and decrease risk of cancers of the colon and rectum: Evidence from the combined analysis of 13 case-control studies. Journal of the National Cancer Institute, 84 (24), 1887-1896.

Jaro, M.A. (1989). Advances in Record-Linkage Methodology as Applied to Matching the 1985 Census of Tampa, Florida. Journal of the American Statistical Association, 406 (84), 16-22.

Kessler, H., Milsom, J.W. (1999). Cancer of the Colon and Rectum. In R.E. Pollock, J.H. Doroshow, J.G. Geraghty, et al (Eds.). Manual of Clinical Oncology. Canada: Wiley-Liss, Inc.

Landis, S.H., Murray, T., Bolden, S., Wingo, P.A. (1998). Cancer statistics, 1998. CA Cancer Journal for Clinicians, 48 (1), 6-29.

Lee, I.M., Paffenbarger, R.S., Hsieh, C.C. (1991). Physical activity and risk of developing colorectal cancer among college alumni. Journal of the National Cancer Institute, 83 (18), 1324-29.

Leach, F.S., Nicolaides, N.C., Papadopoulous, N., et al. (1993). Mutations of a mutS homolog in hereditary nonpolyposis colorectal cancer. Cell, 75 (6), 1215-25.

Mayberry, R.M., Coates, R.J. (1995). Determinants of Black/White Differences in Colon Cancer Survival. Journal of the National Cancer Institute, 87 (22), 1686-1693.

Miller, B.A., Kolonel, L.N., Bernstein L., et al. (Eds.). (1996). Racial/Ethnic Patterns of Cancer in the United States 1988-1992, National Cancer Institute. (NIH Pub. No. 96-4104). Bethesda, MD.

National Cancer Institute (2000). Colon Cancer- Overview. [On-line]. Available: http://cancernet.nci.nih.gov

Newell, G.R., Mills, P.K. (1986). Low Cancer Rates in Hispanic Women Related to Social and Economic Factors. Women and Health, 11 (3-4), 23-35.

Newland, J.R. (1995). The Gastrointestinal Tract. Pathology. Connecticut: Appleton & Lange.

Newland, J.R. (1995). Neoplasia. Pathology. Connecticut: Appleton & Lange.

Parkin, D.M., Muir, C.S., Whelan, S.L., Gao, Y.T., Ferlay, J. Powell, J. (1992). Cancer Incidence in Five Continents. Lyon: International Agency for Research on Cancer.

Pickle, L.W., Mason, T.J., Howard, N., Hoover, R., Fraumeni, J.F. (1987). Atlas of United States Cancer Mortality among Whites. Bethesda: MD: Public Health Service, National Institutes of Health.

Potter, J.D., Slattery, M.L., Bostick, R.M., et al. (1993). Colon cancer: A review of the epidemology. Epidemiology Review, 15 (2), 499-545.

Reddy, B.S. (1983). Dietary fat and colon cancer. In H. Altrup, G.M. Williams (Eds.), Experimental Colon Carcinogenesis. Boca Raton, Florida: CRC Press, Inc.

Ries, L.A.G., Miller, B.A., Hankey, B.F., et al. (Eds.) (1999). SEER Cancer Statistics Review, 1973-1996: Tables and Graphs, National Cancer Institute. (NIH Pub. No. 99-2789). Bethesda, MD.

Sandler, R.S. (1996). Epidemiology and risk factors for colorectal cancer. Gastroenterology Clinics of North America, 25 (4), 717-734.

Shai, D. (1986). Cancer Mortality, Ethnicity, and Socioeconomic Status: Two New York City Groups. Public Health Reports, 101 (5), 547-52.

Slattery, M.L., Sorenson, A.W., Mahoney, A.W., et al. (1988). Diet and colon cancer: Assessment of risk by fiber type and food source. Journal of the National Cancer Institute, 80, 1474-1480.

Texas Department of Health (2000). Texas Cancer Data. [On-line]. Available: http://www.tdh.state.us/tcr/

Texas Cancer Data Center (2000). The impact of cancer on Texas. [On-line]. http://www.txcancer.org

Thun, M.J., Namboodiri, M.M. (1991). Aspirin use and reduced risk of fatal colon cancer. New England Journal of Medicine, 325 (23), 1593-6.

Thomas, R.M., Sobin, L.H. (1995). Gastrointestinal Cancer. Cancer, 75 (1 Supplement), 154-69.

Trichopoulos, D., Petridou, E., Lipworth, L., Adami, H-O. (1997). Epidemiology of cancer. In V.T. DeVira, S. Hellman, and S.A. Rosenberg (Eds.). Cancer: Principles and Practice of Oncology. Philadelphia: Lippincott-Raven.

Trock, B., Lanza, E., Greenwald, P. (1990). Dietary fiber, vegetables, and colon cancer: critical review and meta-analyses of the epidemiologic evidence. Journal of the National Cancer Institute, 82 (8), 650-61.

Vena, J.E., Graham, S., Zielezny, M., Brasure, J., Swanson, M.K. (1987). Occupational exercise and risk of cancer. American Journal of Clinical Nutrition, 45 (1 Supplement), 318-327.

Weaver, P., Harrison, B., Eskander, G., et al. (1989). Colon cancer in blacks: a disease with a worsening prognosis. Journal of the National Medical Association, 83 (2), 133-36.

Wells, B.B., Halsted, J.A. (1967). Diseases of the intestines. Clinical Pathology-Interpretation and Application. Philadelphia and London: W.B. Saunders Company

Willett, W.C., Stampfer, M.J., Colditz, G.A., et al. (1990). Relation of meat, fat, and fiber intake to the risk of colon cancer in a prospective study among women. New England Journal of Medicine, 323 (24), 1664-72

Wu, A.H., Paganini-Hill, A., Ross, R.K., et al. (1987). Alcohol, physical activity and other risk factors for colorectal cancer – a prospective study. British Journal of Medicine, 55 (6), 687-94.