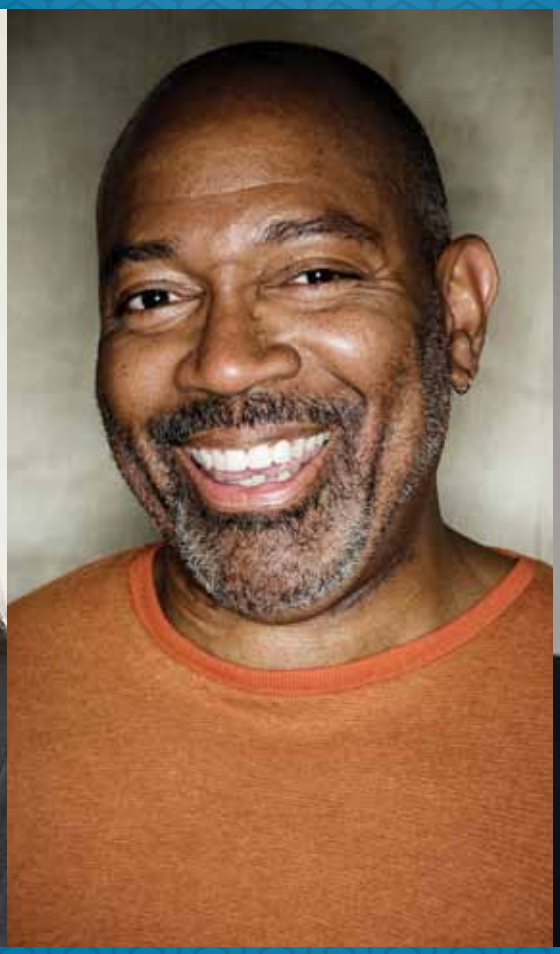
COLORECTAL CANCER

IN TEXAS, 2010



TEXAS Department of State Health Services
Texas Cancer Registry
CPRIT
CANCER PREVENTION & RESEARCH INSTITUTE OF TEXAS

A SPECIAL THANKS TO THE DEDICATION AND HARD WORK OF TEXAS'S CANCER REGISTRARS AND OTHERS RESPONSIBLE FOR DATA COLLECTION ACROSS THIS STATE.

The Texas Department of State Health Services and Cancer Prevention and Research Institute work collaboratively in support of the Texas Cancer Registry and the fight against cancer.

ABOUT THE TEXAS CANCER REGISTRY

The Texas Cancer Registry (TCR), Texas Department of State Health Services is a statewide population-based registry that serves as the foundation for measuring the Texas cancer burden, comprehensive cancer control efforts, health disparities, progress in prevention, diagnosis, treatment, and survivorship, as well as supports a wide variety of cancer-related research. These priorities cannot be adequately addressed in public health, academic institutions, or the private sector without timely, complete, and accurate cancer data.

ABOUT THE CANCER PREVENTION RESEARCH INSTITUTE OF TEXAS

The Cancer Prevention and Research Institute of Texas (CPRIT) is the state agency established to: create and expedite innovation in the area of cancer research and to enhance the potential for a medical or scientific breakthrough in the prevention of cancer and cures for cancer; attract, create, or expand research capabilities of public or private institutions of higher education and other public or private entities that will promote a substantial increase in cancer research and in the creation of high-quality new jobs in this state; and develop and implement the Texas Cancer Plan.

RECOGNITION OF FUNDING SOURCES

Maintaining a statewide cancer registry that meets both National Program of Cancer Registries Centers for Disease Control and Prevention (CDC) high quality data standards and North American Association of Central Cancer Registries (NAACCR) gold certification is accomplished through collaborative funding efforts.

In 2005, the Texas Legislature provided additional funding for the Texas Cancer Registry to achieve and maintain national high quality data standards and certification. With this new funding, the TCR attained both CDC high quality data standards and gold certification from NAACCR for the first time. These standards have been maintained through funding from the Texas Department of State Health Services, the Higher Education Coordinating Board, and now through the Cancer Prevention and Research Institute of Texas.

The TCR also acknowledges the CDC for its financial support under Cooperative Agreement #5U58DP000824. The contents of this report are solely the responsibility of the authors and do not necessarily represent the official views of the CDC.

Requested Citation:
Risser DR, Mokry B, Bowcock C, Miller EA, Williams MA, Magid R, Garcia R. Colorectal Cancer in Texas, 2010. Austin, TX: Texas Cancer Registry, Texas Department of State Health Services; Cancer Prevention Research Institute of Texas, November, 2010.

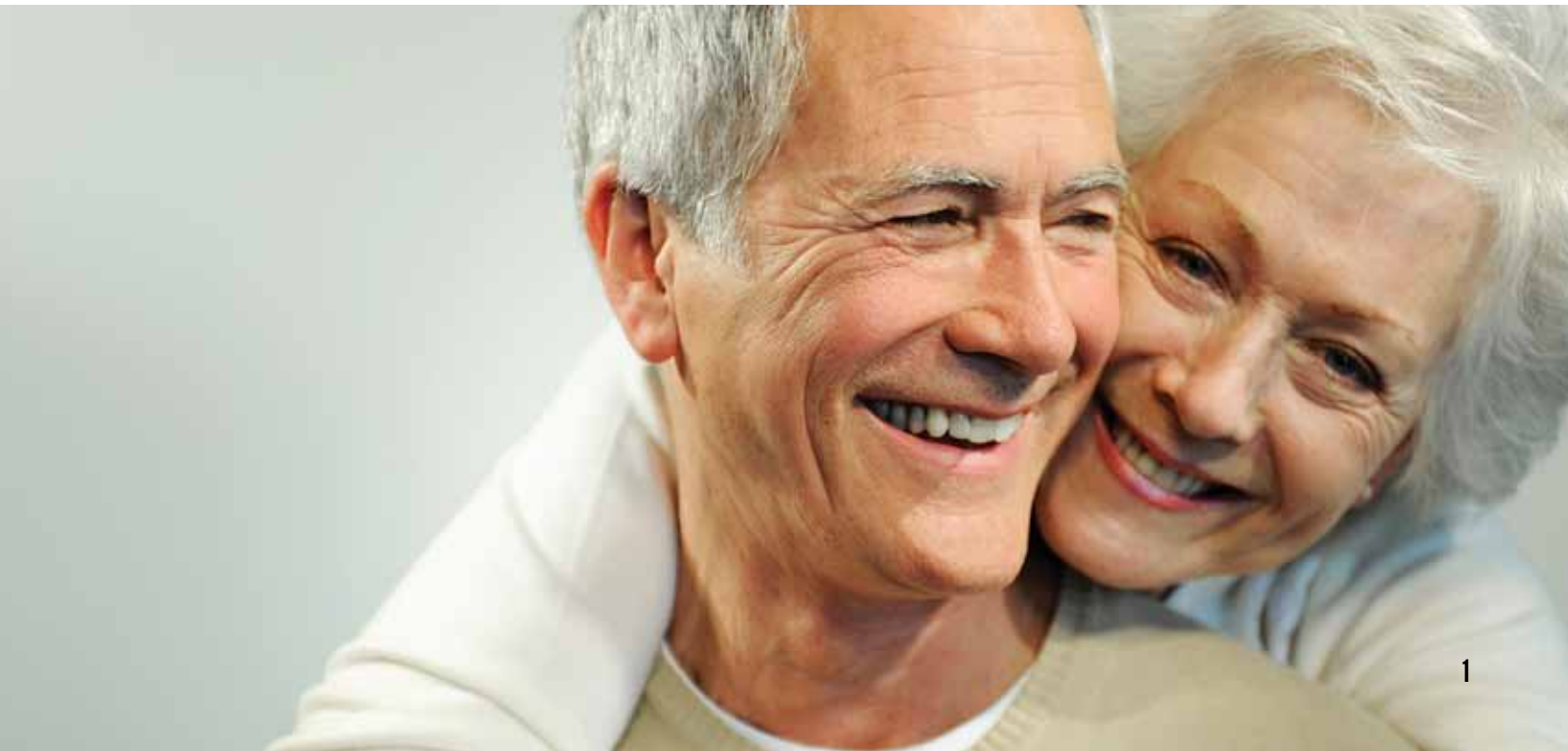
COLORECTAL CANCER IN TEXAS, 2010

COLORECTAL CANCER IS THE THIRD MOST COMMONLY DIAGNOSED CANCER AMONG MEN AND WOMEN IN TEXAS.

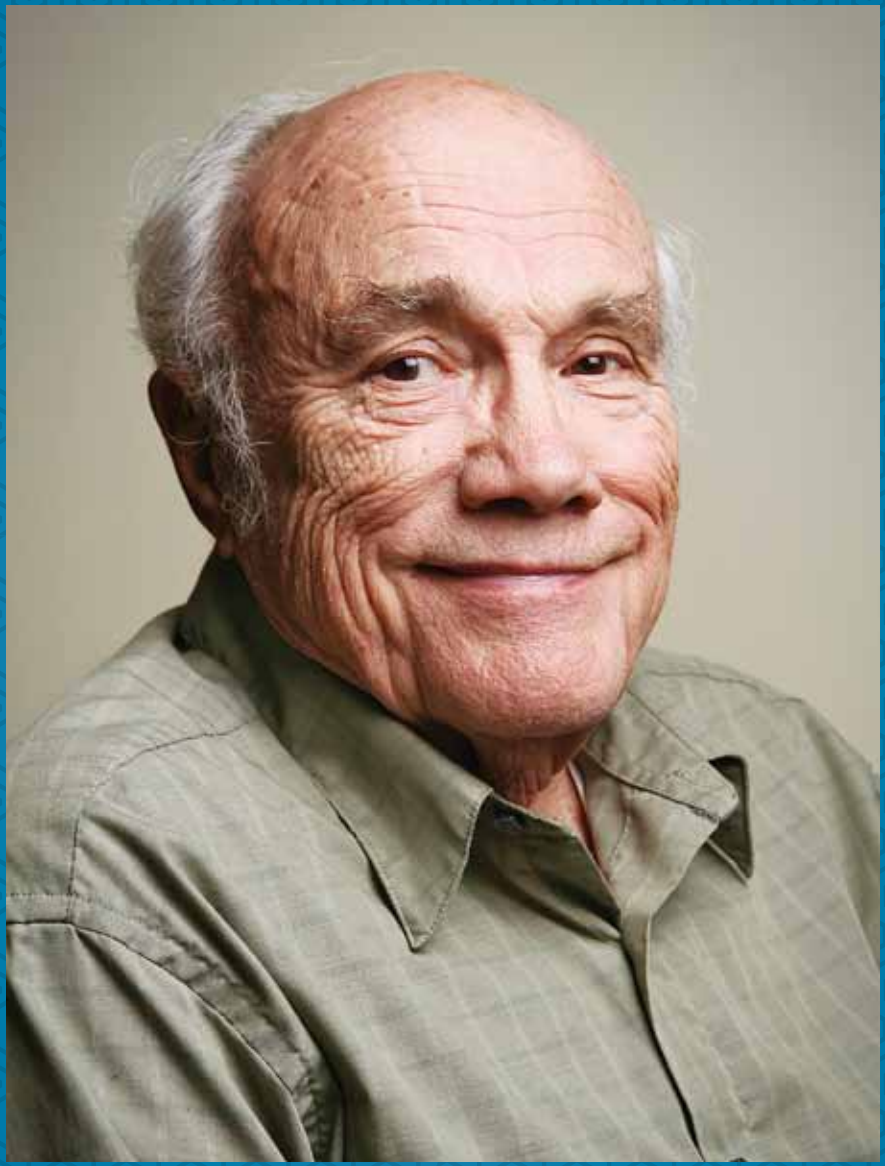
EXECUTIVE SUMMARY

Colorectal Cancer in Texas, 2010, is just one of the steps taken by the Texas Cancer Registry, Texas Department of State Health Services and the Cancer Prevention Research Institute of Texas to describe and better understand the impact of colorectal cancer on the residents of our state. Each number and statistic presented represents not only a cancer patient but also the family, friends, and countless others affected by this disease. Information provided in this report can be used to plan cancer control activities, target and evaluate interventions, and ultimately save lives.

- Colorectal cancer is the third most commonly diagnosed cancer in men and women and the second leading cause of cancer deaths overall.
- In 2010 it is estimated that 10,366 Texans will be newly diagnosed with invasive colorectal cancer, and 3,578 will die of the disease.
- The estimated total cost of colorectal cancer in Texas for 2007 was almost $3.6 billion.
- Blacks have the highest colorectal cancer incidence and mortality rates, followed by non-Hispanic whites and Hispanics.
- Non-Hispanic whites and Hispanics along the Texas-Mexico border have lower incidence and mortality rates than non-Hispanic whites and Hispanics in non-border counties.
- There are higher colorectal cancer incidence and mortality rates in rural counties compared to urban counties.
- In Texas, 44.5 percent of adults aged 50 years and older reported having a sigmoidoscopy or colonoscopy in the last five years, and 14.1 percent reported having an annual blood stool test.



“Screening Saves Lives.”



COLORECTAL CANCER IN TEXAS, 2010

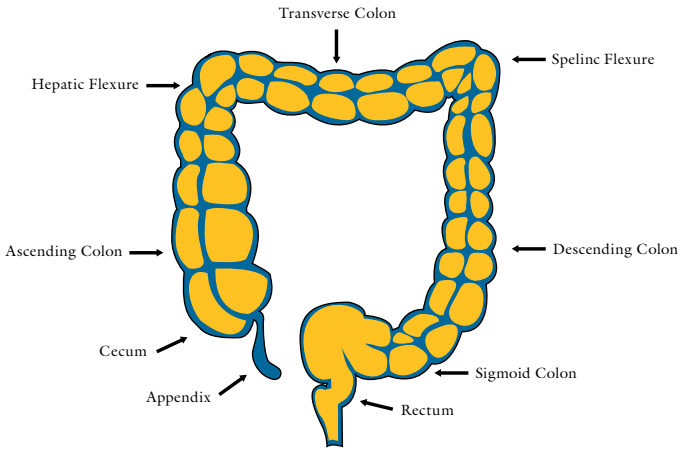
In Texas and the United States, colorectal cancer is the third most commonly diagnosed cancer in men and women and the second leading cause of cancer deaths overall. In 2010 an estimated 10,366 Texans will be newly diagnosed with invasive colorectal cancer, and 3,578 will die of the disease. Colorectal cancer is also extremely costly to the state of Texas. The estimated total cost of colorectal cancer in Texas for 2007 was almost $3.6 billion.[1]

OVERVIEW OF COLORECTAL CANCER

Colorectal cancer refers to all cancers occurring in the colon and rectum, which form the large intestine. The colon and rectum are part of the digestive system and absorb nutrients and water from food and remove waste from the body. The colon is a very long organ (about 5 feet long) that can be further subdivided into additional segments, or sub-sites. These sub-sites include the ascending colon, transverse colon, descending colon, and sigmoid colon (Figure 1). Cancers originating in these sub–sites differ in both demographic distribution and etiology.[2,3]

Most colorectal cancers develop from polyps or adenomas, which are benign (noncancerous) growths in the lining of the colon that have the potential to become malignant (i.e., cancerous). When a polyp becomes malignant, over time it can grow or extend through the lining of the colon or rectum and spread into other organs, tissues, or vessels. Cancer cells that enter into blood or lymph vessels can travel to distant organs in the body, a process referred to as metastasis. As with most cancers, the earlier the tumor can be detected, the better chance of survival.

FIGURE 1. Anatomy of the Colon and Rectum (Subsites)



STAGE OF DISEASE AT DIAGNOSIS

Stage denotes the physical characteristics of malignant tumors, particularly the size and degree of growth and spread. In colorectal cancer, as in most cancers, the stage at diagnosis determines treatment options as well as an estimate of survival. Colorectal cancer tumors may be classified into four summary stage categories. In-situ colorectal cancer tumors are not included in cancer incidence rates but are described below.

In situ – No penetration of malignancy of basement membrane, noninvasive (i.e., carcinoma in a polyp only).

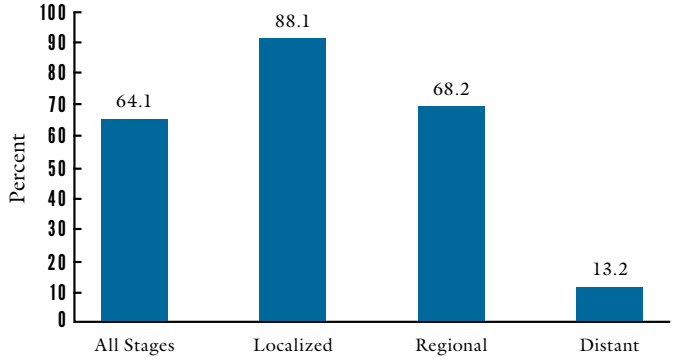
Localized – Invasive tumor is entirely confined to the colon itself.

Regional – Tumor has extended directly to adjacent organs, tissues, or lymph nodes.

Distant – Tumor has spread to distant organs or lymph nodes, a process known as metastasis.

There are important public health implications to colorectal cancer stage at diagnosis because when diagnosed at an earlier stage, the cancer can be better treated and controlled. For example, five-year survival for colorectal cancer diagnosed at a localized stage is 88 percent (all races combined), while for distant stage, the five-year survival is only 13 percent (Figure 2).

FIGURE 2. Five-Year Stage-Specific Relative Survial Rates, Colorectal Cancer, Texas, 2000–2007



Survival Rates are from the Texas Cancer Registry, "Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER Prep 2.4.3" SEER Stat Version 6.6.2 survival analysis, with follow-up through December, 2007.

HOW MANY TEXANS ARE DIAGNOSED WITH AND DIE FROM COLORECTAL CANCER?

From 2003–2007, colorectal cancer was the third most commonly diagnosed cancer among men and women in Texas.

- A total of 45,846 Texans were newly diagnosed with invasive colorectal cancer during this time period, with an average of 9,169 cases per year.
- The average annual age-adjusted colorectal cancer incidence rate was 46.5 cases per 100,000.

From 2002–2006* mortality from colorectal cancer was the second leading cause of cancer deaths among men and third among women.

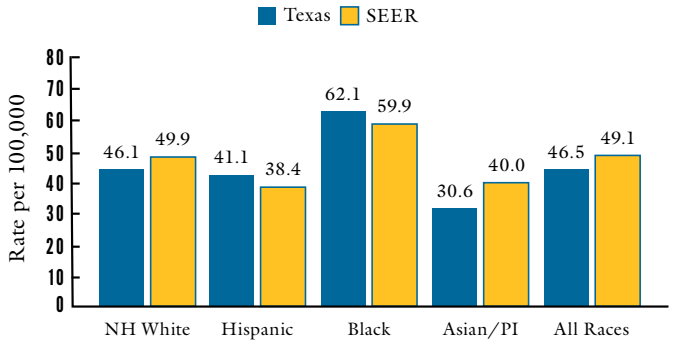
- The number of colorectal cancer deaths during this time period was 16,329, or 3,266 deaths per year.
- The age-adjusted mortality rate was 17.4 deaths per 100,000.

RATES BY SEX, RACE, AND ETHNICITY

Being diagnosed with colorectal cancer or dying from colorectal cancer varies by sex, race, and ethnicity.

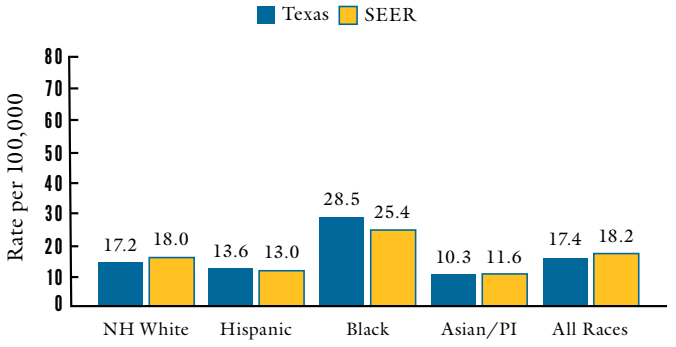
- Colorectal cancer incidence and mortality rates were similar in Texas as compared with the National Cancer Institute's Surveillance Epidemiology and End Results (SEER)[4] program for each race and Hispanic ethnicity (Figures 3 and 4).
- Blacks in Texas had slightly higher incidence and mortality rates than SEER, while Asian/Pacific Islanders had slightly lower incidence and mortality rates (Figures 3 and 4).[4,5]
- Both non-Hispanic whites and blacks in Texas experienced higher colorectal cancer incidence and mortality rates than Hispanics or Asian/Pacific Islanders (Figures 3 and 4).

FIGURE 3. Colorectal Cancer Incidence Rates, Texas (2003–2007), Compared with SEER (2002–2006) by Race and Ethnicity



Rates are average annual rates per 100,000, age–adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Cancer Statistics Review, 1975–2006; Table 6.18 (SEER 17 Areas).

FIGURE 4. Colorectal Cancer Mortality Rates, Texas (2002–2006), Compared with SEER (2002–2006) by Race and Ethnicity



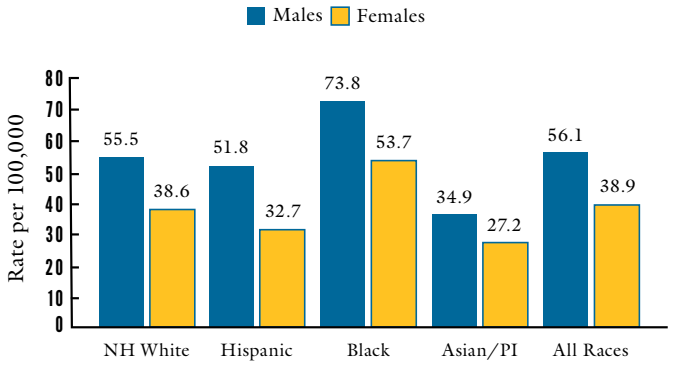
Rates are average annual rates per 100,000, age–adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Cancer Statistics Review, 1975–2006; Table 6.18 (SEER 17 Areas).

*The 2007 statistical death file from the DSHS Center for Health Statistics was not available at the time this report was produced. Therefore, mortality data are only presented through 2006.

- Colorectal cancer incidence and mortality rates are lower in women than in men, both in Texas and SEER (Figures 5 and 6).

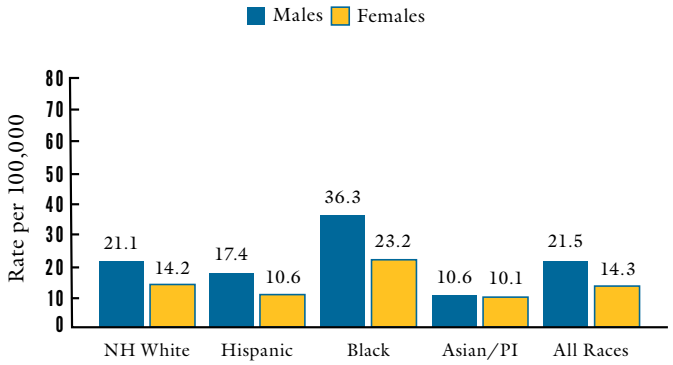
- Black males have the highest colorectal cancer incidence and mortality rates overall.

FIGURE 5. Colorectal Cancer Incidence Rates by Race, Ethnicity and Sex, Texas, 2003–2007



Rates are average annual rates per 100,000 population, age–adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

FIGURE 6. Colorectal Cancer Mortality Rates by Race, Ethnicity and Sex, Texas, 2002–2006



Rates are average annual rates per 100,000 population, age–adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Pop-Adj, SEER*Prep 2.4.0.

- Of the 9,170 average annual cases of colorectal cancer diagnosed among Texans between 2003–2007, 7,338 (80.1 percent) were diagnosed in persons aged 55 years and older (Table 1).

TABLE 1. Average Annual Colorectal Cancer Cases and Percentage of Total New Cancers by Age at Diagnosis, Texas, 2003–2007

	Overall		Males		Females	
Age	N	%	N	%	N	%
0–34	126	1.4	64	1.3	62	1.5
35–44	415	4.5	220	4.5	195	4.6
45–54	1,291	14.1	702	14.3	589	13.8
55–64	1,967	21.5	1,166	23.8	801	18.7
65–74	2,338	25.5	1,333	27.2	1,005	23.5
75–84	2,151	23.5	1,083	22.1	1,068	25.0
85+	882	9.6	327	6.7	555	13.0
Total	9,170	100	4,895	100	4,275	100

Average annual counts are rounded to the nearest whole.
Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

- Of the 3,266 average annual colorectal cancer deaths among Texas residents between 2002–2006, 2,797 (85.6 percent) were among persons aged 55 years and older (Table 2).

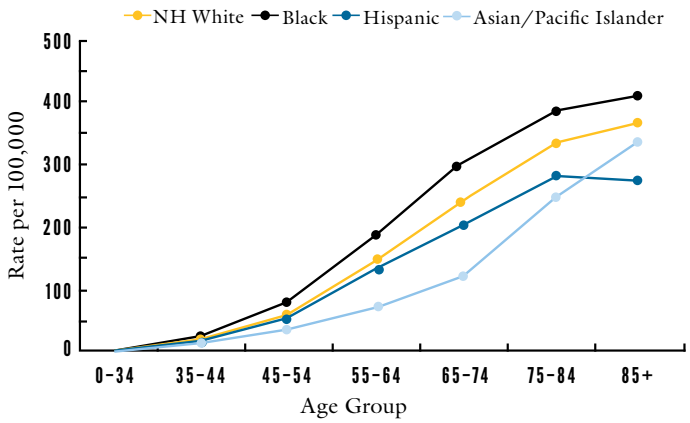
TABLE 2. Average Annual Colorectal Cancer Deaths and Percentage of Total Cancer Deaths by Age at Death, Texas, 2002–2006

	Overall		Males		Females	
Age	N	%	N	%	N	%
0–34	26	0.8	14	0.8	12	0.8
35–44	105	3.2	56	3.3	48	3.1
45–54	338	10.3	198	11.5	140	9.1
55–64	569	17.4	348	20.2	221	14.3
65–74	741	22.7	434	25.2	307	19.9
75–84	931	28.5	478	27.8	453	29.3
85+	556	17.0	191	11.1	365	23.6
Total	3,266	100	1,719	100	1,546	100

Average annual counts are rounded to the nearest whole.
Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Pop-Adj, SEER*Prep 2.4.0.

- Colorectal cancer incidence rates rise rapidly by age group, with a steep rise after ages 45–54. This pattern is consistent by sex and race/ethnicity (Figures 7 and 8).
  - The highest age-specific rates of colorectal cancer occurred among blacks, and the lowest age-specific rates were among Hispanics and Asian/Pacific Islanders.
  - Blacks aged 85 years and older had the highest rate of any group.

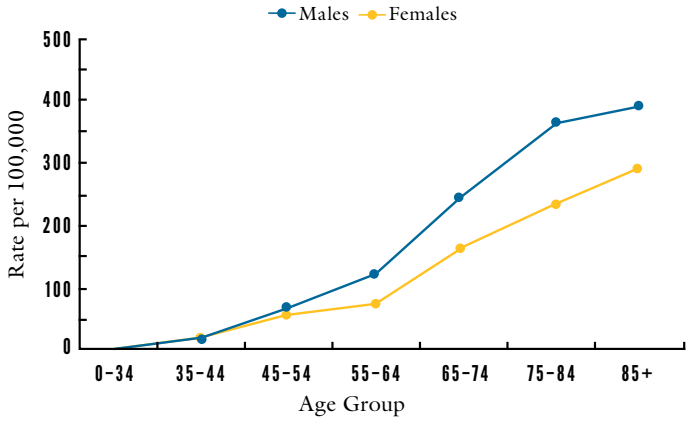
FIGURE 7. Age–Specific Colorectal Cancer Incidence Rates by Race and Ethnicity, Texas, 2003–2007



Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

  - Rates among males and females are similar through ages 45–54 years, but rates among males are higher for each age group after that.

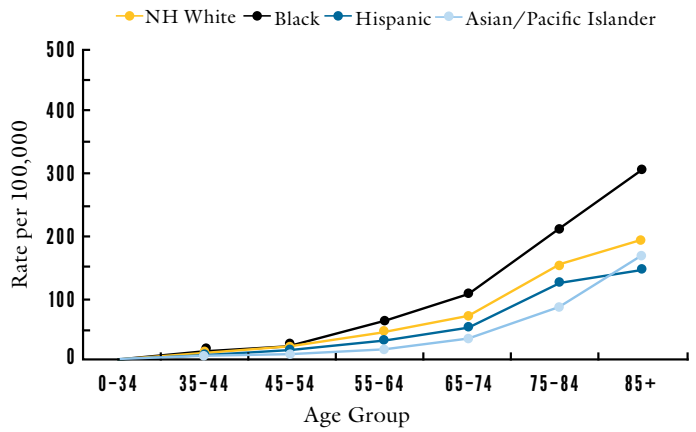
FIGURE 8. Age-Specific Colorectal Cancer Incidence Rates by Sex, Texas, 2003–2007



Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

- The highest rates of colorectal cancer deaths occurred among blacks (Figure 9) and in males of every age group (Figure 10).
  - Blacks aged 85 years and older had by far the highest mortality rates (304.0 per 100,000) followed by non-Hispanic whites (201.8 per 100,000).

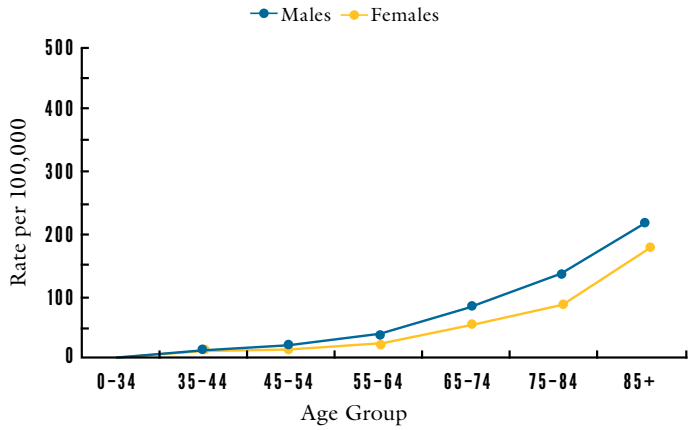
FIGURE 9. Age-Specific Colorectal Cancer Mortality Rates by Race/Ethnicity, Texas, 2002–2006



Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Pop-Adj, SEER*Prep 2.4.0.

  - Similar to incidence, mortality rates do not differ very much until after ages 45–54, when the rates among males increase more with increasing age than females.

FIGURE 10. Age-Specific Colorectal Cancer Mortality Rates by Sex, Texas, 2002–2006



Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Pop-Adj, SEER*Prep 2.4.0.

DISTRIBUTION BY STAGE AT DIAGNOSIS

Differences by diagnosis stage and by race and ethnicity for colorectal cancer are shown in Table 3. For comparison purposes, this report combines the three invasive stages of disease into two more general categories. "Early" colorectal cancer is limited to the localized stage only, while "late" includes both regional and distant stages.

- From 2003–2007, 37.5 percent of all colorectal cancer cases were diagnosed at the early, or localized, stage, and 52.3 percent were diagnosed at the late stage. However, 10.2 percent of cases during that time period had an unknown stage at diagnosis.

- The greatest proportion of early colorectal cancer diagnoses was found among non-Hispanic whites (38.8 percent), followed by Asian/Pacific Islanders (35.9 percent), and Hispanics (35.5 percent). American Indians/Alaskan Natives and blacks had the lowest percentages of cases diagnosed at the early stage (28.4 percent and 33.6 percent, respectively), but they also had the highest percentage of cases with unknown stage at diagnosis (12.6 percent and 10.8 percent, respectively).

TABLE 3. Distribution of Malignant Colorectal Cancer Stage at Diagnosis by Race/Ethnicity and Sex, 2003–2007

	Total			Males			Females		
	Early	Late	Unknown	Early	Late	Unknown	Early	Late	Unknown
	%	%	%	%	%	%	%	%	%
All Races	37.5	52.3	10.2	38.1	52.5	9.5	36.8	52.1	11.1
NH White	38.8	51.3	9.9	39.5	51.3	9.2	38.1	51.2	10.7
Black	33.6	55.2	11.2	33.6	56.6	9.8	33.6	53.8	12.6
Asian/PI	35.9	55.2	8.9	37.5	53.0	9.5	34.3	57.5	8.2
AI/AN	28.4	61.7	9.9	34.1	56.1	9.8	22.5	67.5	10.0
Hispanic	35.5	54.4	10.1	36.2	54.2	9.6	34.6	54.6	10.8

Early=Localized Stage.
Late=Regional and Distant Stages.

Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

TRENDS IN COLORECTAL CANCER RATES

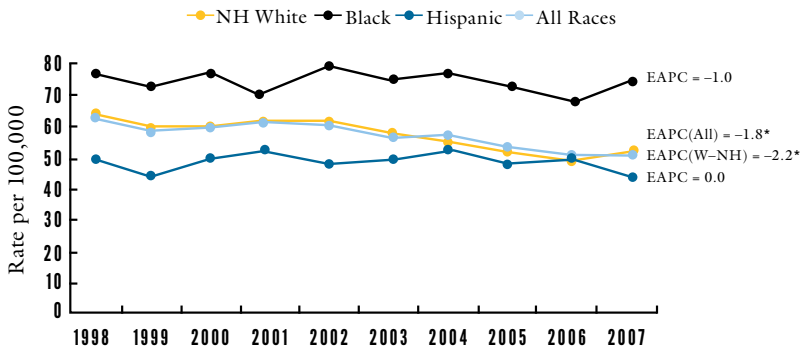
Trends in colorectal cancer incidence were examined to determine whether the rates are changing. Figures 11a and 11b present trends in colorectal cancer incidence from 1998–2007 for males and females, respectively.

- During this time period, the incidence rates for colorectal cancer have been declining in Texas overall. For all races combined, the decline in annual percent change was the same and was statistically significant for both males and females [Estimated annual percent change (EAPC)=–1.8].

- By race and ethnicity, black females had a statistically significant decrease in incidence rates (EAPC=1.1).

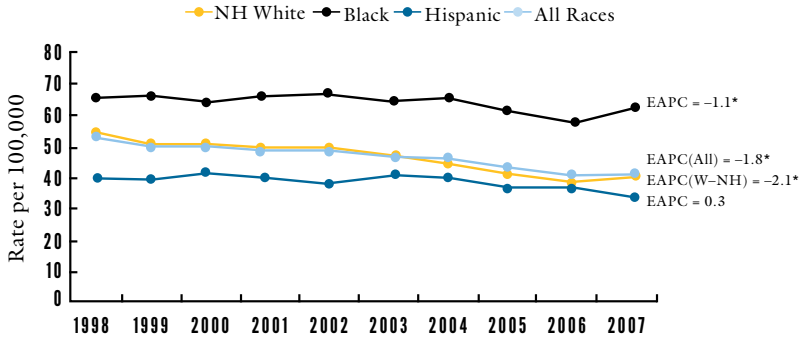
- Although the rate has been declining since 2001, the decline among black males from 1998–2007 is not statistically significant (EAPC=–1.0). The decline among non-Hispanic whites was statistically significant in both males (EAPC=–2.2) and females (EAPC=–2.1). There was no statistically significant difference in rates over time among Hispanic males or females.

FIGURE 11a. Trends in Age-Adjusted Colorectal Cancer Incidence Rates by Race and Ethnicity, Texas Males, 1998–2007



*Estimated annual percent change (EAPC) is statistically significant at $p < 0.05$.
Rates are per 100,000 and age adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence–Texas, 1995–2007, Cut–off 11–19–09, SEER*Prep 2.4.3.

FIGURE 11b. Trends in Age-Adjusted Colorectal Cancer Incidence Rates by Race and Ethnicity, Texas Females, 1998–2007



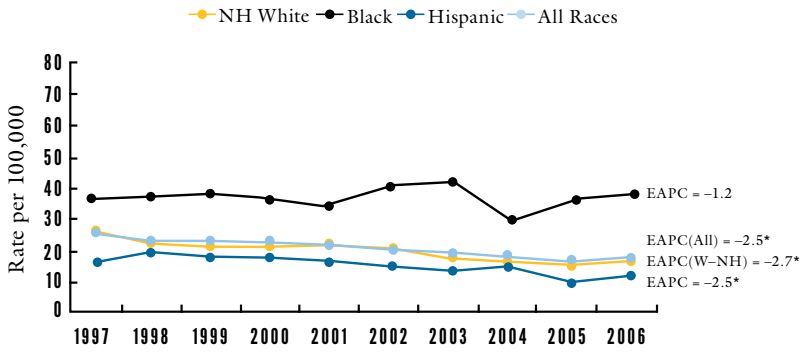
*Estimated annual percent change (EAPC) is statistically significant at $p < 0.05$.
Rates are per 100,000 and age adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence–Texas, 1995–2007, Cut–off 11–19–09, SEER*Prep 2.4.3.

Figures 12a and 12b present trends in colorectal cancer mortality rates by race and ethnicity for males and females, respectively, over the 10-year period of 1997–2006.

- Similar to incidence rates, colorectal cancer mortality rates have been declining. For all races combined, there was a statistically significant decline in mortality rates for both males (EAPC=–2.5) and females (EAPC=–2.7).

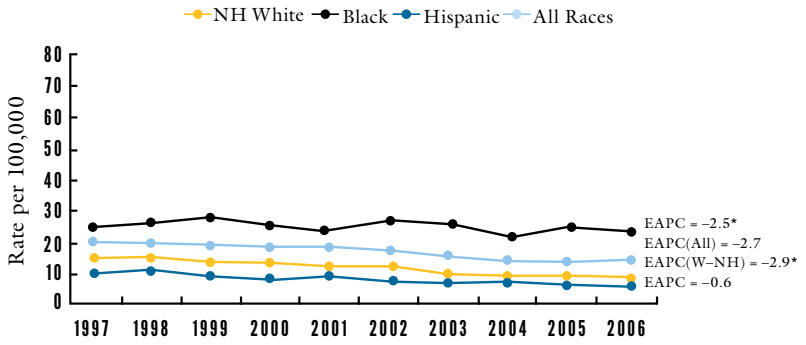
- By race and ethnicity, only black males (EAPC=–1.2) and Hispanic females (EAPC=–0.6) did not have statistically significant declines in mortality rates.

FIGURE 12a. Trends in Age-Adjusted Colorectal Cancer Mortality Rates by Race and Ethnicity, Texas Males, 1997–2006



*Estimated annual percent change (EAPC) is statistically significant at $p < 0.05$.
Rates are per 100,000 and age adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Pop-Adj, SEER*Prep 2.4.0.

FIGURE 12b. Trends in Age-Adjusted Colorectal Cancer Mortality Rates by Race and Ethnicity, Texas Females, 1997–2006



*Estimated annual percent change (EAPC) is statistically significant at $p < 0.05$.
Rates are per 100,000 and age adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Pop-Adj, SEER*Prep 2.4.0.

DISTRIBUTION BY COLON SUB-SITES

Cancers originating in different segments of the colon and rectum differ in both demographic distribution and etiology. In this report, sub-sites are presented by proximal and distal regions of the colon as well as the rectum and rectosigmoid junction (the region where the sigmoid colon transitions into the rectum). The proximal colon is the portion of the colon that runs from the cecum to the splenic flexure (Figure 13). The distal colon includes those sites that occur after the splenic flexure but before the rectosigmoid junction. Texas colorectal cancer incidence data are provided according to major bowel segments in Table 4.

- Females had a substantially higher proportion of colorectal cancers occur in the proximal colon (44.6 percent) than males (36.8 percent).
- Males had a substantially higher percentage of colorectal cancers occurr in the rectum and rectosigmoid junction (30.8 percent) than did females (24.5 percent).
- Black males and females had the lowest proportion of colorectal cancers occur in the rectum and rectosigmoid junction, compared with other race or ethnic groups.

FIGURE 13. Anatomy of the Colon and Rectum

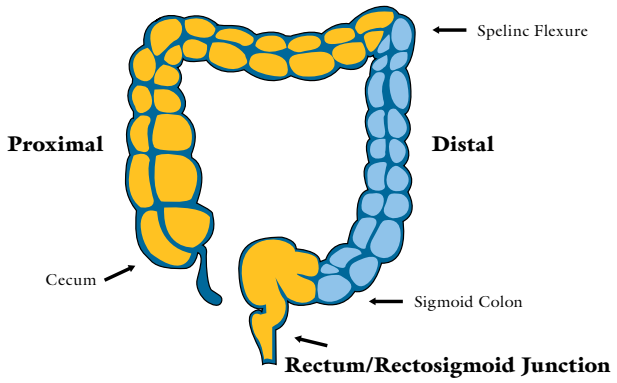


TABLE 4. Distribution of Colorectal Cancer by Colon Sub-Site and by Race/Ethnicity and Sex, 2003–2007

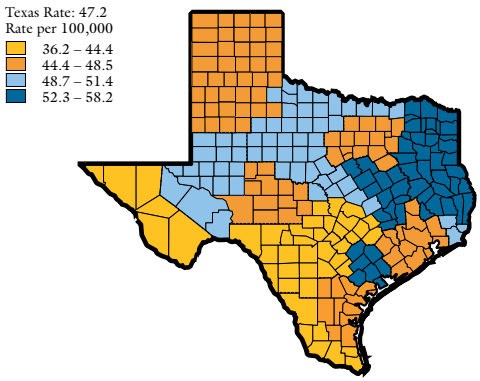
	Proximal		Distal		Rectum/Rectosigmoid Junction	
	N	%	N	%	N	%
Overall (All Races)	18,550	40.5	14,541	31.7	12,755	27.8
Male	9,014	36.8	7,931	32.4	7,527	30.8
Non-Hispanic White	6,128	38.1	5,119	31.9	4,823	30.0
Black	1,178	40.7	954	33.0	760	26.3
Hispanic	1,571	31.7	1,646	33.2	1,740	35.1
Asian/Pacific Islander	92	24.3	140	36.9	147	38.8
Female	9,536	44.6	6,610	30.9	5,228	24.5
Non-Hispanic White	6,492	46.1	4,169	29.6	3,424	24.3
Black	1,355	46.6	938	32.3	615	21.1
Hispanic	1,518	39.4	1,312	34.1	1,022	26.5
Asian/Pacific Islander	123	34.8	125	35.4	105	29.7

Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

GEOGRAPHIC VARIATION OF COLORECTAL CANCER IN TEXAS

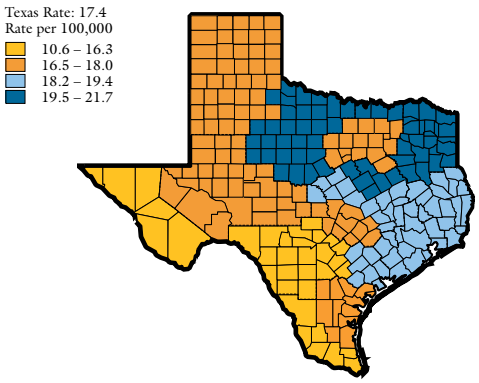
Colorectal cancer incidence and mortality rates vary across the state. The Texas-Mexico border, regional differences in demographic profiles, and large urban and rural portions of our state make Texas unique, presenting a number of challenges for reducing the burden of colorectal cancer. Regional maps of cancer incidence and mortality are presented by county groupings based on Texas Regional Councils of Government (COG) and are shown in Figures 14 and 15. By COG, the highest rates of cancer incidence are found in East Texas while the highest mortality rates are found in East and North Texas.

FIGURE 14. Distribution of Colorectal Cancer Incidence Rates by Council of Government, Texas, 2002–2006



Age-Adjusted to the 2000 U.S. Standard Population.

FIGURE 15. Distribution of Colorectal Cancer Mortality Rates by Council of Government, Texas, 2002–2006



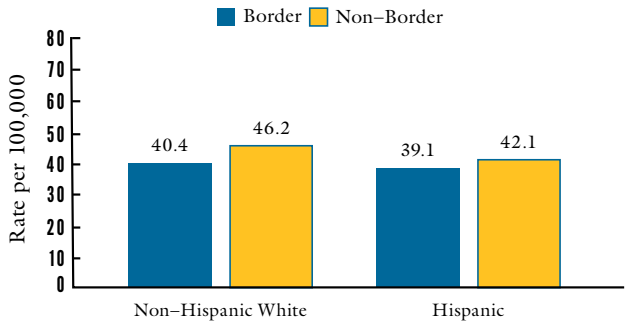
Age-Adjusted to the 2000 U.S. Standard Population.

TEXAS–MEXICO BORDER

Thirty-two counties within 100 km of the Texas-Mexico border are designated as border counties. These counties are among the poorest in the U.S.[6] and have numerous barriers to health education and access to health care. Because many health conditions are found to be worse in the border region compared with the rest of the state, special attention is given to monitor disparities along the border. With respect to colorectal cancer, incidence and mortality rates are actually lower along the border.

- From 2003–2007, non-Hispanic whites and Hispanics in the Texas-Mexico border counties experienced lower colorectal cancer incidence rates (40.4 and 39.1 per 100,000, respectively) when compared with their non-border counterparts (46.2 and 42.1 per 100,000, respectively), and these differences were statistically significant (Figure 16).

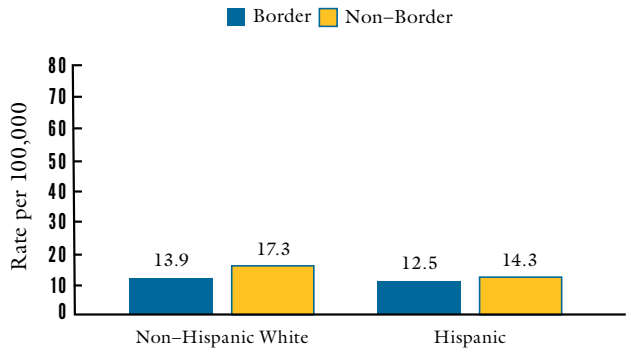
FIGURE 16. Colorectal Cancer Incidence Rates Compared by Border and Non–Border Counties, Texas, 2003–2007



Rates are average annual rates per 100,000, age–adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

- Colorectal cancer mortality followed a similar pattern and was statistically significantly lower in both Hispanics and non-Hispanic whites along the border (12.5 and 13.9 per 100,000, respectively) compared to their non-border counterparts (14.3 and 17.3 per 100,000, respectively) (Figure 17).

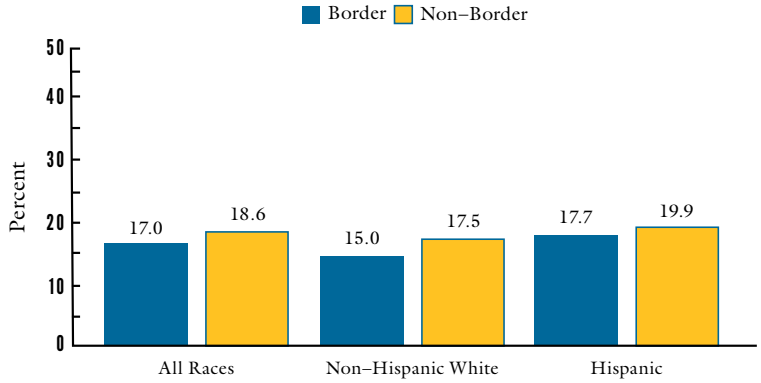
FIGURE 17. Colorectal Cancer Mortality Rates Compared by Border and Non–Border Counties, Texas, 2002–2006



Rates are average annual rates per 100,000, age–adjusted to the 2000 U.S. Standard Population.
Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Pop-Adj, SEER*Prep 2.4.0.

- Overall, 17.0 percent of people living in border counties were diagnosed at the late stage, compared with 18.6 percent of the population in non-border areas (Figure 18).

FIGURE 18. Late (Distant) Diagnosis of Colorectal Cancer In Border and Non–Border Counties, Texas, By Race and Ethnicity 2003–2007



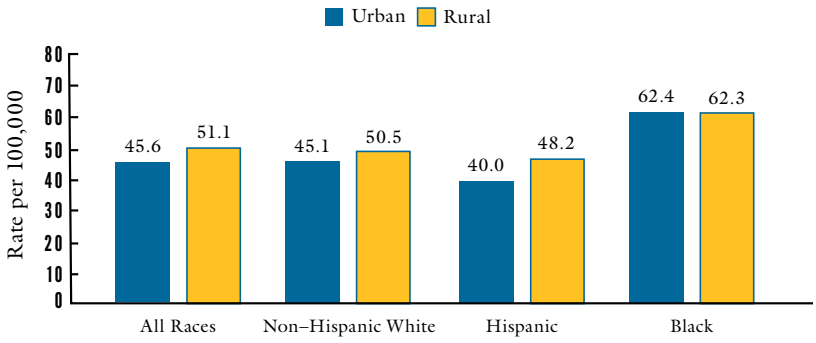
Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

URBAN AND RURAL COUNTIES

Studies have identified differences in colorectal cancer incidence and mortality in urban areas compared with rural areas.[7] In this report, Texas counties are categorized by degree of urbanization and population size based on the Rural-Urban Continuum Codes, which are designated by the U.S. Office of Management and Budget (http://www.ers.usda.gov/briefing/rurality/ruralurbcon/). Comparisons are made between metropolitan counties (Urban) and non-metropolitan counties (Rural). There was an extremely small number of Asian/Pacific Islanders living in rural counties, and thus very few colorectal cancer cases or deaths within that group. As a result, Asian/Pacific Islanders living in rural counties were not included in the urban and rural county analyses.

- From 2003–2007, there was significantly higher colorectal cancer incidence rates in rural counties compared with urban counties for all races, non-Hispanic whites, and Hispanics (Figure 19).

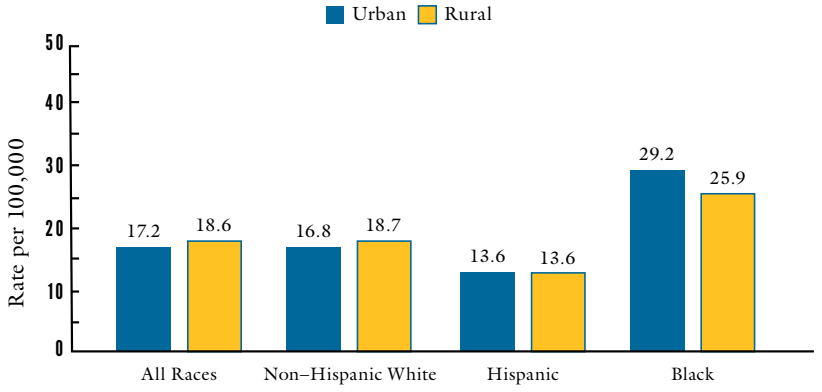
FIGURE 19. Colorectal Cancer Incidence Rates Compared by Urban and Rural Counties, Texas, 2003–2007



Rates are average annual rates per 100,000, age–adjusted to the 2000 U.S. Standard Population.
Urban/rural designations by U.S. Office of Management and Budget: Beale2003 (Beale 1–3 Urban, Beale 4–9 Rural).
Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

- Colorectal cancer mortality rates for 2002–2006 (Figure 20) were also significantly higher in Texas rural counties compared with urban counties for all races as well as for non-Hispanic whites. However, none of the other racial or ethnic differences were statistically significant.

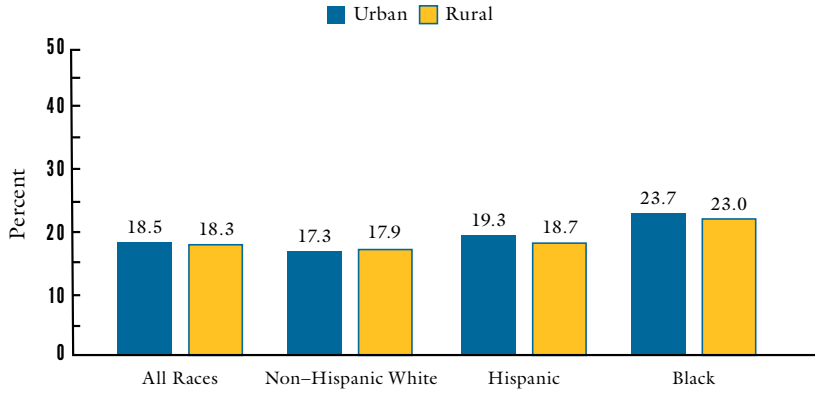
FIGURE 20. Colorectal Cancer Mortality Rates Compared by Urban and Rural Counties, Texas, 2002–2006



Rates are average annual rates per 100,000, age–adjusted to the 2000 U.S. Standard Population.
Urban/rural designations by U.S. Office of Management and Budget: Beale2003 (Beale 1–3 Urban, Beale 4–9 Rural).
Source: Texas Department of State Health Services, Center for Health Statistics, Mortality – Texas, 1990-2006, file created 03-31-09, SEER Pop-Adj, SEER*Prep 2.4.0.

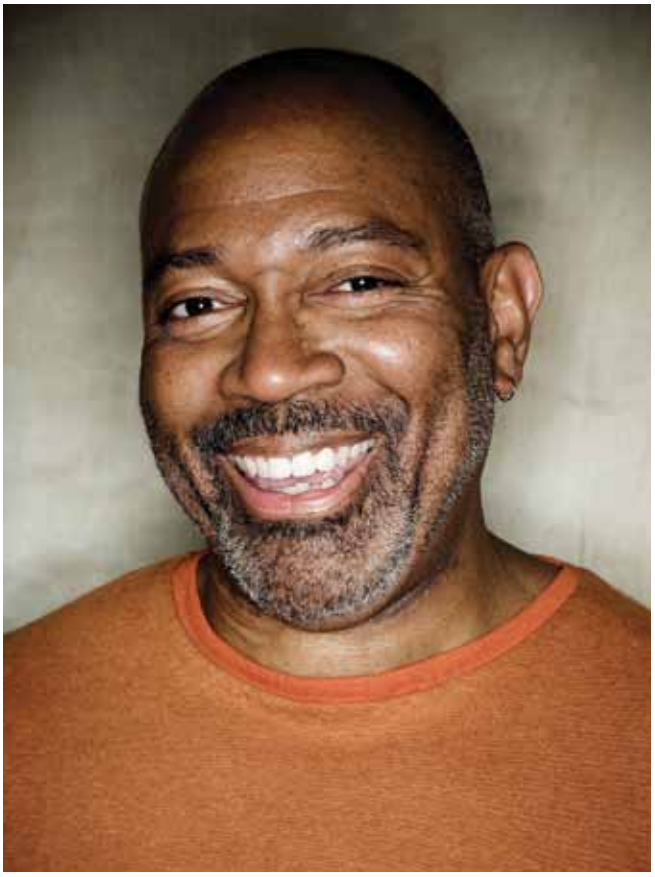
- There was little difference in the stage at diagnosis distribution in urban and rural counties, overall and by race and ethnicity in Figure 21.

FIGURE 21. Late (Distant) Diagnosis of Colorectal Cancer In Urban and Rural Counties, Texas, By Race and Ethnicity 2003–2007



Urban/rural designations by U.S. Office of Management and Budget: Beale2003 (Beale 1–3 Urban, Beale 4–9 Rural).
Source: Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry, Incidence – Texas, 1995-2007, Cut-off 11-19-09, SEER*Prep 2.4.3.

These patterns are consistent with other studies of urban/rural differences in cancer incidence and mortality, both in Texas and in other regions.



The purpose of screening is to detect a disease or condition before a person exhibits symptoms, and, by detecting and treating the disease or condition early, improve the outcome the person experiences. On a population level, screening is intended to reduce mortality rates from the condition or disease. Regular cancer screening is extremely important for colorectal cancer. Not only can colorectal cancer screening help detect cancers early, which can improve survival, but it can even prevent cancer from developing by removing noncancerous polyps before they become cancer. It is very important for colorectal cancer to be detected and treated early since stage at diagnosis is the most significant prognostic factor in survival. It is estimated that approximately half of the deaths from colorectal cancer could have been prevented through screening.[8]

Screening tests for colorectal cancer include tests to detect polyps and cancer (flexible sigmoidoscopy, colonoscopy, double contrast barium enema, computed tomographic colonography) and tests that primarily detect cancer (fecal occult blood test, stool DNA test). Screening guidelines were updated in 2008. For adults aged 50 years and older and of average risk, the guidelines include:[9]

- Tests that detect adenomatous polyps and cancer
  - — Flexible sigmoidoscopy every 5 years, or
  - — Colonoscopy every 10 years, or
  - — Double–contrast barium enema every 5 years, or
  - — Computed tomographic colonography every 5 years.
- Tests that primarily detect cancer
  - — Annual guaiac–based fecal occult blood test with high sensitivity for cancer, or
  - — Annual fecal immunochemical test with high sensitivity for cancer, or
  - — Stool DNA test with high sensitivity for cancer, interval uncertain.

Patients of higher risk for colorectal cancer should discuss their screening options with their physician. Patients of higher risk include patients with previously identified polyps, previously diagnosed colorectal cancer, family history, or heritable conditions, such as familial adenomatous polyposis or hereditary non-polyposis colorectal cancer.

SCREENING USE IN TEXAS

The Behavioral Risk Factor Surveillance System (BRFSS) is an ongoing survey that collects data on lifestyle risk factors. The surveys in 2004, 2006, and 2008 included questions about colorectal cancer screening among those aged 50 years and older. Selected results are presented in Table 5.

- Overall, 44.5 percent of Texans reported having a sigmoidoscopy or colonoscopy in the last five years, and 14.1 percent reported having an annual blood stool test.
- There were no significant differences in screening by gender, but males were slightly more likely to have had any type of screening (annual blood stool test, sigmoidoscopy/colonoscopy in the last five years).
- Blacks had the highest prevalence of an annual blood stool test (16.1 percent), and Hispanics had a much lower prevalence (9.4 percent) — a statistically significant difference.
- All race/ethnicities were more likely to have had a sigmoidoscopy/colonoscopy in the last five years than an annual blood stool test, but non-Hispanic whites had a significantly higher prevalence for this test (48.0 percent) than Hispanics (33.9 percent). Blacks (43.9 percent) were not significantly different for this screening test than non-Hispanic whites.
- Colorectal cancer screening is more prevalent among those with higher education.
- There was a statistically significant lower prevalence of annual blood stool testing in border counties (11.8 percent) than in non–border counties (14.3 percent).
- Similarly, the prevalence of sigmoidoscopy/colonoscopy in the last five years was significantly higher in urban counties (46.2 percent) than in rural counties (39.5 percent).

TABLE 5. Prevalence of Colorectal Cancer Screening Among Those Aged 50+ Years Texas BRFSS, 2004, 2006, and 2008

	Had Annual Blood Stool Test[a]			Had Sigmoidoscopy/Colonoscopy in Past 5 Years[b]		
	N	%	95% Confidence Interval	N	%	95% Confidence Interval
Statewide Total	12,460	14.1	(13.2 – 14.9)	12,504	44.5	(43.2 – 45.9)
Age						
50 – 59	4,441	10.1	(9.0 – 11.3)	4,435	35.1	(33.1 – 37.3)
60 – 69	3,734	16.9	(15.2 – 18.8)	3,754	50.4	(48.0 – 52.8)
70+	4,285	17.7	(16.2 – 19.4)	4,315	54.1	(51.9 – 56.3)
Gender						
Male	4,430	15.3	(13.9 – 16.7)	4,445	45.0	(42.9 – 47.2)
Female	8,030	13.0	(12.0 – 14.1)	8,059	44.1	(42.5 – 45.7)
Race/Ethnicity						
White	9,106	15.2	(14.2 – 16.3)	9,159	48.0	(46.4 – 49.6)
Black	846	16.1	(13.1 – 9.7)	845	43.9	(39.2 – 48.6)
Hispanic	2,133	9.4	(7.9 – 11.2)	2,124	33.9	(30.9 – 37.0)
Other	288	12.1	(8.0 – 17.9)	290	35.9	(28.8 – 43.6)
Education						
< HS Graduate	2,054	10.4	(8.8 – 12.3)	2,035	32.8	(29.8 – 35.9)
HS Graduate	3,264	14.0	(12.4 – 15.7)	3,259	41.5	(39.2 – 44.0)
Some College	3,203	14.9	(13.3 – 16.7)	3,229	44.4	(41.8 – 47.1)
College Graduate +	3,888	15.4	(13.9 – 17.2)	3,928	53.1	(50.6 – 55.5)
Texas-Mexico Border/Non-Border						
Border Total	1,410	11.8	(9.6 – 14.4)	1,417	36.6	(33.1 – 40.3)
Non–Border Total	10,675	14.3	(13.4 – 15.3)	10,711	45.6	(44.2 – 47.1)
Texas Urban (Metro) and Rural Counties						
Urban Total	9,510	14.5	(12.5 – 16.7)	9,544	45.6	(44.6 – 47.7)
Rural Total	2,575	12.6	(11.1 – 14.2)	2,584	39.5	(37.2 – 41.9)

Among those aged 50 years and older…
a …the proportion who had a blood stool test in the past year using a home kit.
b …the proportion who had a sigmoidoscopy/colonoscopy in the past five years.
Note: All reported rates (percents) are weighted for Texas demographics and the probability of selection.
Source: Texas Behavioral Risk Factor Surveillance System, 2004, 2006, 2008 Combined Year Dataset.

WHAT ARE THE RISK FACTORS?

Researchers have identified a number of risk factors that increase a person's chance of developing colorectal cancer.[10,11] Having these risk factors does not indicate that a person will get colorectal cancer, but it does indicate an increased likelihood of developing the cancer.

The following are considered risk factors for colorectal cancer:

Age: As is true for most types of cancer, the risk for colorectal cancer increases with age. The incidence rate for colorectal cancer begins to increase significantly after age 55 in both males and females (Figures 7 and 8). However, colorectal cancer can and does occur at any age.

Family and Personal Medical History: Having a parent or sibling who has had colorectal cancer, especially if diagnosed at an early age, substantially increases the risk of being diagnosed with colorectal cancer. There are also known heritable conditions that lead to colorectal cancer, such as familial adenomatous polyposis and hereditary nonpolyposis colorectal cancer. These hereditary cancers may account for as much as 10–15 percent of the colorectal cancers in the United States.[11] Other medical conditions that have been found to be associated with an increased risk of colorectal cancer include a previous colorectal cancer, having adenomatous polyps, and chronic inflammatory bowel disease.

Diet: Numerous studies from all over the world have explored the role of diet in either causing or preventing cancers of the colon and rectum. Diets high in red and processed meats have been shown to increase the risk of colorectal cancer,[12,13] while there is some evidence that diets high in calcium, vitamin D, and fruits and vegetables might help reduce the risk.[14,15,16]

Obesity/Overweight: It has been suggested that about 25 percent of all cancer cases globally are due to excess weight and sedentary lifestyle.[17] Colorectal cancer has been particularly linked to obesity. The association is positive in both men and women, but there is evidence the association is stronger in men.[18]

Diabetes: Diabetes has also been associated with an increased risk of colorectal cancer, but the evidence has been mixed. A recent review of earlier studies found that diabetes was associated with an increased risk of colorectal cancer compared with no diabetes. This finding was consistent between case-control and cohort studies, between United States and Europe, and the association did not differ by sex.[19]

Physical Inactivity: Physical inactivity has also been suggested to be related to colorectal cancer due to the relationship with obesity and diabetes already discussed. There are studies that indicate a strong association[20,21] as well as studies suggesting no consistent association.[22]

SOURCES OF DATA

The Texas Cancer Registry (TCR) collects incident reports of neoplasms occurring among state residents, including certain benign tumors and borderline malignancies. The incidence rates in this report are for primary malignant neoplasms.

The TCR is a population-based reporting system. Texas hospitals and cancer treatment centers are the primary sources of case reporting. Additionally, information is sought for Texas residents who are diagnosed and treated at facilities outside of Texas. The incidence data used in this report were primarily abstracted from medical records and pathology reports.

The completeness of the 2003–2007 incidence data was evaluated by applying California's age, sex, and race and ethnic-specific cancer incidence rates to the Texas population in order to generate an expected number of cases. California rates were used because of more complete California Cancer Registry case ascertainment for some types of cancer and similarity between Texas and California populations. Based on these calculations, the 2002–2006 data presented here are estimated to be 98.3 percent complete. The incidence file used a cut-off date of November 19, 2009.

Cancer mortality data through 2006 were extracted from electronic files provided by DSHS, Center for Health Statistics (CHS). These files contained demographic and cause of death information from Texas death certificates for all deaths occurring among Texas residents. The 2007 death file was not available at the time this report was produced.

CONFIDENTIALITY

Protecting the confidentiality of persons whose cancers are reported to the TCR is the highest priority of the Registry in all aspects of operations and is required by state law and rule (Health and Safety Code, §82.009; Texas Administrative Code, Title 25, Part 1, Chapter 91, Subchapter A). No data presented in this report are intended to be used to identify individuals who have been diagnosed with cancer.

PRIMARY SITE CODES

Primary anatomic site and histologic type were coded for each cancer incident case using the International Classification of Diseases for Oncology (ICD–O). For cases diagnosed from 1995–2000, the second edition was used (ICD–O–2)[23] and for cases diagnosed from 2001–2007, the third edition was used (ICD–O–3).[24] Cases were then recoded into SEER program site recode groups for classifying types of cancer, using SeerPrep version 2.3.2 software. The ICD–O–3 codes for colorectal cancer incidence included in this report are C189–C209 and C260 (excluding morphological types 9050:9055; 9140, 9590:9989).

For cancer mortality data, the TCR classifies anatomic site according to the SEER "Cause of Death Recode," as given by the SEER Cause of Death Recode 1969+ (9/17/2004) (http://seer.cancer.gov/codrecode/1969+_d09172004/index.html). For reporting of cancer mortality data, SEER has defined major site groups based on the ICD versions 9 and 10. These site groups are defined consistently across time to facilitate reporting of long term trends. The ICD10 site codes for colorectal cancer mortality are C18–C20, C26.0.

DATA MANAGEMENT

Data on incident cancers are reported to the TCR in accordance with the Texas Cancer Incidence Reporting Act (Chapter 82, Health and Safety Code). Standard data items are requested on the Confidential Cancer Incidence Reporting Form or in electronic format. These data items are entered into a cancer incident database after being checked for completeness and quality.[25] Multiple reports for the same individual are consolidated to assure the most complete and correct information possible.

CLASSIFICATION BY RACE/ETHNICITY

As of April 2008, the TCR is using the standard race and ethnicity groupings as used by the SEER (NCI) program as well as NAACCR (North American Association of Central Cancer Registries) and NPCR (National Program of Cancer Registries). Therefore, all of the race groups will be slightly different from what has been used in the past, and will enable us to generate rates for Texas Asian/Pacific Islanders and American Indians/Alaskan Natives. More information about these race and ethnicity groupings can be found at the following link: http://seer.cancer.gov/seerstat/variables/seer/race_ethnicity/.

Race and ethnicity information for cancer cases is based primarily on information contained in the patient's medical record. This information may be supplied directly by the patient, may be determined by admissions staff or other medical personnel, and/or can be based on last name, race, or ethnicity of parents, birthplace, or maiden name. The reporting of race or ethnicity may be influenced by the race and ethnic distribution of the local population, by local interpretation of data collection guidelines, and other factors. It is possible that some differences in race and ethnic-specific rates reflect biases of classification rather than true differences in risk.

The race and ethnicity of each cancer patient is classified according to the categories defined in the NAACCR Coding Manual.[24] Incidence data for Hispanics are based on the NAACCR Hispanic Identification Algorithm (NHIA). The race and ethnic groups used in this report include the following categories: non-Hispanic white, black, Hispanic, Asian/Pacific Islander, and American Indian/Alaskan Native (Figure 1). Hispanic is not mutually exclusive from whites, blacks, Asian/Pacific Islanders, and American Indian/Alaskan Natives. Hispanics can therefore be of any race, but from 2002–2006, 97.2 percent of Hispanics in Texas diagnosed with colorectal cancer were of the white race, and from 1997–2006, 98.4 percent of colorectal cancer deaths in Hispanics were of the white race.

POPULATION DATA

Estimates of the population used for the calculation of rates were obtained from the SEER program of the NCI, instead of the Texas State Data Center, as has been used in the past. This new data source and information about the derivation of these population data can be found at the following link: http://seer.cancer.gov/popdata/. For 2003–2007, the largest group is the non-Hispanic white population, with 49.8 percent of the state population. Texas Hispanics compose 34.9 percent of the total population, blacks represent 12.0 percent of the total population, and Asian/Pacific Islanders represent 3.5 percent. For 1998–2007, non–Hispanic whites represent 51.4 percent of the state population, Hispanics 33.6 percent, blacks 12.0 percent and Asian/Pacific Islander 3.3 percent. These groups are not mutually exclusive and do not include American Indian/Alaskan Natives, and therefore will not add to 100 percent.

CANCER INCIDENCE DATA QUALITY

Numerous quality assurance procedures are applied to the data based on the SEER Program procedures and NAACCR standards. The quality control procedures include both internal and external processes to ensure the reliability, completeness, consistency, and comparability of TCR data. The internal process included a review of the hard copy abstract for multiple primaries, duplicate records, and valid codes for all fields.

Both hard copy and computerized data were scrutinized for identification of: 1) possible duplicates of existing records, 2) unacceptable codes for any field, or inter-field inconsistencies, and 3) invalid or unusual site/sex, age/site, age/morphology or site/morphology combinations. Inconsistencies in date of birth, race, ethnicity, sex, county of residence, date of diagnosis, site, and histologic type were rectified. Multiple primaries for an individual were identified among the various reports during the editing process. Information on the same primary from duplicate reports was consolidated and checked for consistency and legitimate codes.

External procedures included hospital training, on-site case-finding studies, re-abstracting studies, and death clearance cancer death certificate files were matched against reported incident cases for an additional check of reporting completeness.

To identify any cancer cases not reported to the TCR, information on all death certificates with the underlying cause of death due to malignant neoplasm was obtained from the Bureau of Vital Statistics, Texas Department of State Health Services. Institutions listed on the death certificates as place of death were queried for additional cancer case information. Missed cases not identified from any institution were added to the cancer database. Cases for which the only available information is the death certificate, classified as "death certificate only" cases, were included in this report. The date of death was considered to be the date of diagnosis for these cases. From 2003–2007, 1.8 percent of colorectal cancer cases were "death certificate only" cases.

The percentage of cases microscopically confirmed measures the quality of the diagnostic information on which the assignment of primary site is based. A case is microscopically confirmed if the diagnosis is based on autopsy, histology, cytology, or hematology findings. Of the total 2003–2007 colorectal cancer cases, 95.9 percent were microscopically confirmed.

DATA ANALYSIS

In this report, average annual incidence and mortality rates were age-adjusted using the direct method. Age adjustment eliminates the effects of differences in the age structure between populations and allows direct comparison of incidence and mortality rates for these populations. Direct standardization weights the age-specific rates by the age distribution of the standard population. The 2000 United States standard million population was used as the standard for all calculations.[26]

The incidence and mortality rates and frequencies used in this report were calculated using SEER*Stat software (version 6.4.4). This software was developed by SEER to analyze population-based cancer registry data, and provides the age-adjusted incidence and mortality rates for the standard set of cancer sites and site groups recognized by the SEER program. Information regarding availability and use of this software can be found on the SEER website: http://seer.cancer.gov/seerstat.

TREND ANALYSIS

The Estimated Annual Percent Change (EAPC) represents the average percent increase or decrease in cancer rates per year over a specified period of time. The EAPC is calculated by fitting a linear regression to the natural logarithm of the annual rates, using calendar year as a predictor variable (formula: $\ln(r) = m(\text{year}) + b$). From the slope of the regression line, m, EAPC is calculated as:

$$\text{EAPC} = 100 \times (e^{m} - 1).$$

Testing the hypothesis that the EAPC is equal to zero is equivalent to testing the hypothesis that the slope of the line in the regression is equal to zero. Statistical significance was set at alpha = 0.05, thus a trend in rates was considered statistically significant if there was less than a 5 percent chance that the difference was the result of random variation. The EAPC assumes that the cancer rate is changing at a constant rate over the interval examined.[27]

Asterisks indicate that the change is statistically significant ($p < 0.05$). Trends should be interpreted with caution because of the relatively short time period for which data are available.

REFERENCES

1. Tan, A, Freeman, DH, Jr., Freeman, JL, et al. (March 2009). The Cost of Cancer in Texas, 2007. Texas Cancer Registry, Texas Department of State Health Services, Publication No. 10–13121.

2. Demers, RY, SR, Schottenfeld, D, Lazar, L. Incidence of colorectal adenocarcinoma by anatomic subsite. Cancer 1997; 79(3): 441–447.

3. Matanoski, G, TX, Almon, L, Adade, AA, Davies-Cole, JO. Demographics and tumor characteristics of colorectal cancers in the United States, 1998–2001. Cancer Supplement 2006; 107(5): 1112–1120.

4. U.S. Cancer Statistics Working Group. United States Cancer Statistics: 1999–2005 Incidence and Mortality Web based Report. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, and National Cancer Institute, 2009.

5. Texas Cancer Registry.

6. The United States–Mexico Border Region at a Glance. In: Commission UBH, ed United States–Mexico Border Health Commission, 2004.

7. Risser, DR. Cancer incidence and mortality in urban versus rural areas of Texas, 1980 through 1985. Tex Med 1996; 92(1): 58–61.

8. Colditz, GA, Atwood, KA, Emmons, K, Monson, RR, Willett, WC, Trichopoulos, D, Hunter, DJ. Harvard report on cancer prevention volume 4: Harvard Cancer Risk Index. Risk Index Working Group, Harvard Center for Cancer Prevention. Cancer Causes Control 2000; 11(6): 477–88.

9. Levin, B ea. Screening and surveillance for the Early Detection of Colorectal Cancer and Adenomatous Polyps. CA Cancer J Clin. Vol. 58 American Cancer Society; US Multimedia task force on colorectal cancer; The American College of Radiology, 2008; 130–160.

10. NCI. What You Need to Know About Cancer of the Colon and Rectum. National Cancer Institute, 2003

11. Schottenfed, D. Cancers of the Large Intestine. In: Schottenfeld, David FJF, Jr., ed. Cancer Epidemiology and Prevention. 2 ed. New York: Oxford University Press, 1996; 820–832.

12. Larsson, SC, WA. Meat consumption and risk of colorectal cancer: a meta–analysis of prospective studies. International Journal of Cancer 2006; 119(11): 2657–2664.

13. Chao, A, TM, Connell, CJ, McCullough, ML, Jacobs, EJ, Glanders, WD, et al. Mean consumption and risk of colorectal cancer. Journal of the American Medical Association 2005;293(2): 172–182.

14. Kushi, LH, BT, Doyle, C, Bandera, EV, McCullough, M, McTiernan A, et al. American Cancer Society Guidelines on Nutrition and Physical Activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. CA Cancer J Clin 2006; 56(5): 254–281.

15. Bosch, FX, Ribes, J, Diaz, M, Cleries, R. Primary liver cancer: worldwide incidence and trends. Gastroenterology 2004; 127(5 Suppl 1): S5–S16.

16. Koushik, A, HD, Spiegelman, D, Beeson, Wl, van den Brandt, PA, Buring, JE, et al. Fruits, vegetables, and colon cancer risk in a pooled analysis of 14 cohort studies. J Natl Cancer Inst 2007; 99(19): 1471–1483.

17. Osorio–Costa, F, RG, Dias, MM, Carvalheira, C. Epidemiological and molecular mechanisms aspects linking obesity and cancer. Arq Bras Endicronol Metab 2009; 53(2): 213–226.

18. Renehan, AG, RD, Dive, C. Obesity and cancer: pathophysiological and biological mechanisms. Arch Physiol Biochem 2008; 114(1): 71–83.

19. Larrson, SC, ON, Wolk, A. Diabetes mellitus and risk of colorectal cancer: A meta–analysis. Journal of the National Cancer Institute 2005; 97(22): 1679–1687.

20. Moradi, T, GG, Bjork, J, Dosemeci, M, Ji, BT, Berkel, HJ, Lemeshow, S. Occupational physical activity and risk for cancer of the colon and rectum in Sweden among men and women by anatomic subsite. Eur J Cancer Prev 2008; 17(3): 201–208.

21. Giovannucci, E, AA, Rimm, EB, Colditz, GA, Stampfer, MJ, Willet, WC. Physical activity, obesity, and risk of colon cancer and adenoma in men. Ann Intern Med 1995; 122(5): 327–334.

22. Hermann, S, RS, Linseisen, J. Lifestyle factors, obesity and the risk of colorectal adenomas in EPIC–Heidelberg. Cancer Causes and Control, 2009.

23. Percy, C, VHV, and Muir, C. International Classification of Disease for Oncology, Second Edition. Geneva: World Health Organization, 1990.

24. Fritz, A, Percy, C, Jack, A, et al. (eds) International Classification of Disease for Oncology. Third edition. 2000, Geneva: World Health Organization.

25. Havener, L, Thornton, M (eds.). Standards for Cancer Registries Volume II: Data Standards and Data Dictionary, Thirteenth Edition, Version 11.3 North American Association of Central Cancer Registries, 2008.

26. Anderson, R, Rosenberg, HM. Age Standardization of Death Rates: Implementation of the Year 2000 Standard. National Vital Statistics Reports, v. 47, no. 3. Centers for Disease Control and Prevention, NCHS, 1998.

27. Rothman, K. Modern Epidemiology. Boston, MA: Little, Brown and Company, 1986.

PUBLICATION NO. 10-13439
SEPTEMBER 2010