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Decreasing Black-White Disparities in Colorectal Cancer Incidence and Stage at Presentation in the United States

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Abstract

Background—There are long-standing black-white disparities in colorectal cancer (CRC) incidence and outcomes in the United States. Incidence and stage at diagnosis reflect the impact of national efforts directed at CRC prevention and control. We aimed to evaluate trends in black-white disparities in both indicators over four decades to inform the future direction of prevention and control efforts.

Methods—We used Surveillance, Epidemiology, & End Results (SEER) data to identify whites and blacks with histologically confirmed CRC from January 1, 1975 through December 31, 2012. We calculated the age-adjusted incidence and the proportion of cases presenting in late stage by race and year. We then calculated the annual percentage change (APC) and average APC for each indicator by race, examined changes in indicators over time, and calculated the incidence disparity for each year.

Results—There were 440,144 CRC cases from 1975 to 2012. The overall incidence decreased by 1.35% and 0.46% per year for whites and blacks, respectively. While the disparity in incidence declined from 2004 to 2012 (APC=−3.88%; p=0.01), incidence remained higher in blacks in 2012. Late stage disease declined by 0.27% and 0.45% per year in whites and blacks, respectively. The proportion of late stage cases became statistically similar in whites and blacks in 2010 (56.60% v. 56.96%; p=0.17).

Conclusion—Black-white disparities in CRC incidence and stage at presentation have decreased over time.

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Impact—Our findings reflect the positive impact of efforts to improve CRC disparities and emphasize the need for interventions to further reduce the incidence gap.

Keywords

disparities; colon cancer; utilization; incidence; stage

INTRODUCTION

Colorectal cancer (CRC) is a major contributor to cancer incidence and cancer-related mortality in the United States (U.S.). Each year, over 130,000 Americans are diagnosed with and over 49,000 die from the disease (1). Diagnosis, management and treatment of CRC are also associated with significant health care costs in the U.S with national expenditures for CRC exceeding $14 billion annually (2).

There are well-documented and long-standing disparities in CRC incidence and outcomes between U.S. whites and blacks (1,3–9). Incidence of CRC in blacks has exceeded incidence in whites since the mid-1980s (1). In addition, blacks carry an excessive burden of disease with the highest mortality and the lowest survival rates following diagnosis when compared to other racial and ethnic groups (1,10–15). Advanced stage disease at presentation also varies by race. Historically, blacks have been more likely to be diagnosed with CRC at late stages than whites, limiting options for treatment and leading to poor survival and mortality outcomes (1,13,15,16). As 5-year survival for stage I CRC is 90%, compared to 13% for those with advanced disease at diagnosis, early disease detection is critical to reducing the burden of CRC (1).

The black-white disparity in CRC outcomes has been attributed to a genetic predisposition to CRC among blacks, a higher prevalence of CRC risk factors in blacks, and differences in access to preventive and healthcare services like cancer screening in blacks compared to whites (4,14,17–31). Efforts to address these inequities have included education about CRC risk factors among blacks and targeted efforts to improve CRC screening uptake in black Americans (14,32–34). Such efforts have likely contributed to the improving black-white disparities in CRC screening uptake in national surveys. Historically, blacks have had lower CRC screening rates than whites; however, recent Centers for Disease Control (CDC) data suggest equivalent CRC screening rates among blacks and whites (35).

The effects of these interventions on black-white disparities in CRC incidence and stage at diagnosis—the outcomes most likely to be influenced by CRC screening—have been less well-described. To conduct a more thorough assessment of national progress towards reducing disparities in CRC outcomes, we examined trends in CRC incidence and stage at diagnosis in U.S whites and blacks from 1975 to 2012. Both of these CRC indicators are amenable to clinical and public health intervention, and thus, provide insight into the impact of screening guidelines, national insurance policy changes, and targeted efforts to increase screening rates on CRC outcomes. Further, knowledge about how CRC disparities have changed over time and have responded to previous efforts will inform future research, implementation strategy, and policy to address ongoing inequities in CRC outcomes.

MATERIALS AND METHODS

Data Source and Study Population

We used data from the National Cancer Institute (NCI) Surveillance, Epidemiology, & End Results (SEER) database (36). Given that our main interest was to examine long-term trends in CRC indicators, our primary analyses were based on SEER 9 registry data, which include malignancies diagnosed in nine U.S. regions from 1975 to 2012 and represents 9.4% of the U.S. population (37). Secondary analyses included rates, proportions, and trends from SEER 13 and SEER 18 registries that provide broader geographic and demographic coverage, but over shorter periods of time. SEER 13 includes tumor registry data from 13 U.S. regions from 1992 to 2012 while SEER 18 includes data from 18 regions from 2000 to 2012 (38,39).

The study cohort included individuals in the SEER program database with histologically confirmed colon or rectal cancer diagnosed between January 1, 1975 and December 31, 2012 as defined by the *International Classification of Diseases for Oncology*, 3RD edition (40). Analyses were limited to U.S. blacks and whites. As the SEER 9 database does not specify Hispanic ethnicity, persons of Hispanic origin are included in their respective racial group category (black or white). The SEER population is comparable to the U.S. population with respect to income level (14.1% v. 14.3% below poverty level) and education (16% v. 14.6% with less than high school diploma) (37). Minority racial and ethnic groups, foreign-born, and urban populations are deliberately overrepresented in the SEER database to ensure adequate representation of groups that are of special interest to the SEER program (41).

Colorectal Cancer Indicators

The two outcomes were incidence and stage at diagnosis. For incidence, we used age-adjusted CRC incidence rates expressed per 100,000 persons as calculated from the 2000 U.S. standard population and provided in the SEER*Stat software version 8.2.1(36). For stage at disease presentation, we categorized tumors as early stage or late stage, using the SEER Historic Stage A variable for extent of disease at diagnosis. The SEER Historic Stage A variable is the only stage variable in SEER that has been recorded consistently from 1975 to 2012. We defined early stage cases as localized disease confined to the colon/rectum or with intraluminal extension but no lymph node involvement at the time of diagnosis. Those presenting with CRC that extended beyond the colon/rectum or to remote parts of the body were categorized as late stage. We excluded patients in the unstaged disease category from stage trend analyses.

Statistical Analyses

We used SEER*Stat version 8.2.1 (April, 2015) to specify the CRC cohort and to obtain frequencies in incidence and proportions for stage for each racial group for each year (36). We then used the Health Disparities Calculator (HD*Calc 1.2.4) provided by the NCI to determine the absolute difference in CRC incidence between blacks and whites for each year (42). In HD*Calc, incidence disparities are provided as the absolute difference in the incidence in whites and blacks for a given year. We also calculated incidence disparities as rate ratios (RR), a measure of the relative difference in rates between whites and blacks for a given year (43).

To evaluate the indicator data for significant linear trends, we used Joinpoint 4.1.1.3 (44). Joinpoint provides the annual percent change (APC) and average annual percent change (AAPC) where APC is the rate of change in an indicator over a one-year period, and AAPC is the weighted average of APCs used to describe an indicator trend over the entire SEER study period (45,46). P-values were calculated for each APC and AAPC where a value less than 0.05 supported a trend change significantly different from zero, and significant APCs and AAPCs represented statistically significant trends in the indicator. In Joinpoint, we also used the comparability test to compare indicator trends in the white and black cohorts, where $p<0.05$ signified significantly different trends in whites and blacks over the given time period. The test of parallelism determined if white and black trends were parallel over a given time period, where $p<0.05$ signified non-parallel trends.

RESULTS

Overall Colorectal Cancer Incidence and Late Stage at Diagnosis

From 1975 to 2012, there were 440,144 CRC cases in the SEER 9 regions. CRC incidence was 54.45 per 100,000 whites and 60.22 per 100,000 blacks (Table 1). Overall, 218,385 (54.81%) whites with CRC presented with late stage disease. In blacks, 23,853 (57.20%) cases were late stage presentations ($p<0.01$) (Table 1).

Black-White CRC Incidence Trends Over Time

Significant linear trends in incidence are presented in Figure 1 for each racial group. In whites, there was a significant increase in CRC incidence by 0.79% per year (APC=0.79, $p<0.001$) from 1975 to 1985 before incidence began to decline in 1985. Incidence declined by 1.98% per year from 1985 to 1995 (APC=−1.98, $p<0.01$), remained statistically stable from 1995 to 1998 (APC=1.65, $p=0.25$), declined by 2.54% per year from 1998 to 2008 (APC=−2.54, $p<0.01$), and further by 4.28% per year from 2008 to 2012 (APC=−4.28, $p<0.01$).

Incidence in blacks rose by 3.32% per year from 1975 to 1980 (APC=3.32, $p<0.01$) and then remained stable from 1980 to 2004 (APC=−0.16, $p=0.08$) (Figure 1). Blacks did not see a significant decrease in CRC incidence until 2004, twenty years after rates in whites began to decline. Incidence in blacks decreased by 3.63% per year from 2004 to 2012 (APC=−3.36, $p<0.01$). Despite this steep decrease, incidence in blacks remained higher than incidence in whites at the end of the study period (47.0 per 100,000 blacks versus 37.6 per 100,0000 whites, $p<0.01$). Over the entire study period, the AAPC was a 1.35% decline per year (AAPC=−1.35, $p<0.01$) in whites, which was significantly different than ($p<0.001$) and not parallel to ($p<0.001$) the 0.46% decline in incidence per year in blacks (AAPC=−0.46, $p<0.01$).

Secondary analyses using a greater number of regions in the SEER 13 and SEER 18 registries supported SEER 9 findings. SEER 13 data demonstrated a rapid decline in incidence in whites from 1992 to 2012 at 2.14% per year (AAPC=−2.14, $p<0.01$) and a less rapid but significant downward trend in incidence in blacks at 1.45% per year (AAPC=−1.45, $p<0.01$) over the same time period. In the largest geographic SEER sample, SEER 18,

both whites and blacks demonstrated declines in incidence from 2008 to 2012: the AAPC was a 2.86% decline per year for whites ($p<0.01$), compared to a 2.38% decline per year in blacks ($p<0.01$). Overall, all three SEER samples supported converging declines in CRC incidence in both whites and blacks since 1975 but demonstrated persistently elevated CRC incidence rates in blacks at the end of the study period. While annual CRC incidence was higher for men than women, men and women had similar incidence trends from the mid-2000s until 2012 in each racial subgroup (data not shown).

The Disparity in Black-White Incidence Over Time

Figure 2 is the Joinpoint graph demonstrating significant trends in the absolute difference in CRC incidence between blacks and whites from 1975 to 2012 as calculated from the SEER 9 database. The incidence difference remained statistically stable from 1975 to 1983 (APC= −5.82, $p=0.39$). During this period, CRC incidence in blacks rose and then exceeded rates in whites (Figure 1). Thus, the downward slope in the absolute difference in incidence graph from 1975 to 1983 (Figure 2) reflects the crossover from higher CRC rates in whites to higher rates in blacks rather than improving disparities. In 1983, the incidence difference was lowest. Due to the dramatic disproportionate decrease in incidence in whites thereafter, however, the difference increased significantly by 5.76% per year from 1983 to 2004 (APC= 5.76, $p<0.01$). The year 2004 marked the maximal difference in incidence in whites and blacks: RD=13.46 per 100,000 (95% CI=9.95 – 16.96). In that year, the RR was 0.79 (95% CI=0.74 – 0.83), suggesting that incidence in whites was 0.79 times or 21% lower than the incidence in blacks. Since 2004, the absolute difference in incidence between whites and blacks has trended downward significantly by 3.88% per year (APC= −3.88, $p=0.01$).

Secondary analyses using the SEER 13 and SEER 18 registries support the SEER 9 findings. In all population samples, the black-white difference in CRC incidence decreased significantly and steadily from the early 2000s until 2012, and incidence in whites exceeding incidence in blacks at the end of the study period.

Black-White Trends in Late Stage at Presentation

In 1975, the proportion of blacks presenting with late stage CRC (70.89%) was higher than the proportion of whites presenting with late stage disease (63.40%; $p<0.001$). For whites, there were periods of both significant increases and significant declines in the proportion of late stage presenting tumors over the study period (Figure 3). The largest decline in late stage presentation in whites was from 1983 to 1987 when rates decreased by 1.69% per year (APC=−1.69, $p<0.01$). This period was followed by an upward trend in incidence of late stage disease at presentation from 1987 to 1995 (APC=0.41, $p=0.01$). At the end of the study period, the proportion of late stage disease cases was increasing by 0.67% per year for whites (APC=0.67, $p<0.01$). Late disease presentation in blacks, on the other hand, declined significantly and steadily at a rate of 0.45% per year throughout the entire study period from 1975 to 2012 (APC= −0.45; $p<0.001$). Consequently, the trends for late stage disease in the two groups converged and were equal by the end of the study period (Figure 3).

Secondary analyses using the SEER 13 and SEER 18 registry data also support a decreasing black-white disparity in stage at presentation over time. In both samples, the decline in late

stage disease in blacks was steeper and over a longer time period than in whites, leading to a convergence of the two trend lines in the last two years of data collection. We did not detect gender differences in these trends in either ethnic group (data not shown).

DISCUSSION

We used the oldest population-based cancer database in the U.S. to demonstrate improving disparities in two major CRC indicators: incidence and stage at presentation. Our results show that although black-white disparities in CRC incidence have improved remarkably since 1975, they persist. Furthermore, we demonstrated that historic black-white disparities in stage at diagnosis may have resolved. Both findings are driven by a disproportionate decline in CRC incidence and late stage presentation in blacks since the early 2000s. Our findings are consistent with the downward trend in incidence disparities seen in the 1999–2012 CDC National Program of Cancer Registries data (47). By looking at long-term disparity trends, our study allows for a broad examination of national progress in CRC prevention and control over the past four decades and provides parallel information on long-term trends in incidence and stage at diagnosis.

Our finding that black-white incidence differences persists while disparities in stage at CRC presentation have resolved suggests that public efforts in CRC prevention and control have been more effective at addressing the mutable factors that affect stage at presentation than incidence. The overall decline in CRC incidence in the past several decades is likely a result of several factors, including changes in lifestyle risk factors, advances in medical technology, public awareness about CRC, and efforts to improve CRC prevention. CRC is associated with cigarette use, high animal fat diet, low fiber diet, low physical activity and obesity (4,17,18,20). These behaviors are also associated with black race and, thus, might contribute to higher incidence in blacks overall and persistent incidence disparities today (4,19,20). In addition, there are historical black-white differences in access to healthcare services and endoscopic procedures like flexible sigmoidoscopy and colonoscopy, procedures that result in the removal of colonic adenomas before malignant transformation (48). CRC is largely preventable with the identification and removal of premalignant colonic adenomas; thus, the earlier decline in CRC incidence among whites is likely at least partially attributable to higher use of these procedures in whites before the early 2000s (49). Higher utilization of endoscopy screening among blacks in recent years may have contributed to an incidence decline in blacks in the early 2000s, several decades after whites (35,48). The literature does not, however, demonstrate a large decline in proximal tumors among blacks or whites from 1975 to present (50). Thus, it does not appear that the significant decline in CRC incidence in blacks was driven solely by the prevention of proximal tumors more commonly seen in this racial subgroup (50,51).

The persistent black-white incidence disparity at the end of the study period may also reflect the role of factors other than screening. Lansdorp-Vogelaar et al used a microsimulation model to estimate contributors to black-white CRC incidence disparities and demonstrated that black-white differences in screening uptake account for only 42% of the disparity in CRC incidence (52). In addition to persistent differences in access to screening services, genetic predisposition to CRC, a higher prevalence of CRC risk factors, and differences in

utilization of services like surveillance colonoscopy and timely diagnostic colonoscopy after abnormal stool-based screening may contribute to the higher incidence of CRC among blacks at the end of the study period (4,14,17–31).

All modalities of CRC screening have the potential to impact stage of disease at presentation, including endoscopy, fecal occult blood testing (FOBT), fecal immunochemical testing (FIT), and stool DNA (sDNA) (53). While stool-based screening examinations are limited in their ability to prevent disease incidence, they are capable of detecting cancerous lesions in early stages if followed with diagnostic colonoscopy (54,55). In national cohorts, the large black-white disparities seen in CRC screening uptake have declined, and recent data from the CDC and the Behavioral Risk Factor Surveillance Survey (BRFSS) demonstrate equal CRC screening rates in blacks and whites at 65% (35). More specifically, rates of FOBT use have declined in blacks while rates of endoscopic screening have increased (56). Thus, increasing use of endoscopic screening methods among blacks and public health attention towards black-white CRC screening disparities may have resulted in a shift towards CRC diagnoses in earlier stages in blacks (35,57,58). While it is essential to see how stage trends continue in the next several years, the implication for stage at diagnosis is that blacks may have benefited disproportionately from collective CRC early detection efforts in recent years.

There are several strengths to the present analysis. First, we used a large, national cancer registry database to determine trends in CRC indicators. SEER uniquely provides access to national population-based data on cancer stage at diagnosis, likely reflecting the influence of national programs and interventions on CRC outcomes. Second, we examined CRC indicator trends over a prolonged period of time. While there are examples in the literature of recent trends in CRC incidence and outcomes, the present study explores data over four decades to comment on long-term black-white disparity trends (47). Third, we performed our analyses using three different SEER program datasets to demonstrate similar trends and conclusions across three somewhat different yet complementary populations.

Our study is not without limitations. The SEER 9 program database lacks designation for Hispanic ethnicity. As there are likely more white Hispanics than black Hispanics and as Hispanics have a lower incidence of CRC but later stage at diagnosis than whites, their inclusion may have overestimated incidence disparities and underestimated stage disparities between whites and blacks (1). A second weakness of our study is that we were not able to directly compare rates and proportions across the SEER 9, 13, and 18 databases because they contain different cancer registry regions and populations. While this fact limited our ability to look at long-term trends for all 18 SEER regions, it did not impact our ability to make relative statements about trends in incidence and stage in blacks compared to whites. Lastly, as the SEER database does not include tumor data for all U.S. geographical areas, our findings may not be generalizable to every region of the country. When comparing SEER age-adjusted CRC incidence rates to incidence rates provided by the North American Association of Central Cancer Registries (available only from 2009 onward), which cover 99% of the U.S. population, SEER rates appear slightly lower (59). While SEER data poses these challenges, it remains the most powerful tool to investigate national cancer disparities and is the best available source for long-term cancer data in the U.S.

In conclusion, our findings support improvement in inequities in CRC incidence and stage at diagnosis over the past four decades. Contrary to the body of literature demonstrating disparities in CRC incidence and outcomes in cross-sections of the population and within various healthcare systems, the present study suggests that longitudinal evaluation of CRC indicators points to at least some progress in the nation as a whole (6,60–63). While these improvements in CRC disparities are encouraging, our results do not suggest that the decades-long challenge to eliminate disparities in CRC has been fully accomplished. Efforts to improve CRC prevention and early detection may have halted the widening gap in CRC disparities, however, inequities in CRC incidence persist. The challenge now is to identify the factors that have been most effective in reducing disparities so that we can develop interventions that will continue to bend the CRC incidence curve in blacks and maintain equity in stage at diagnosis. In addition, future work must evaluate disparity trends in other CRC indicators like mortality and survival.

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Abbreviations

CRC	colorectal cancer
U.S	United States
SEER	Surveillance, Epidemiology, & End Results
APC	annual percentage change
AAPC	average annual percentage change
CDC	Centers for Disease Control
NPCR	National Program of Cancer Registries
NCI	National Cancer Institute
FOBT	fecal occult blood testing
FIT	fecal immunochemical testing
sDNA	stool DNA

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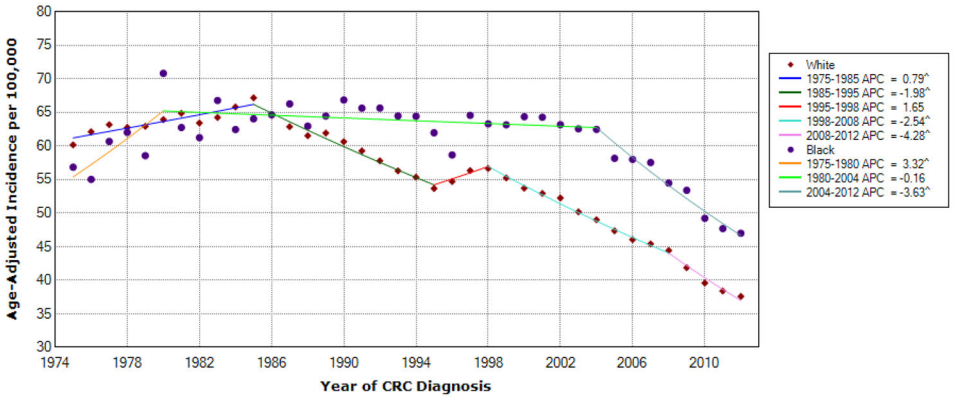

Figure 1.

Evaluation for significant linear trends in CRC incidence in whites and blacks, SEER 9 (1975–2011)*

*Rates are per 100, 000 and age-adjusted to the 2000 U.S. standard population. APC indicates annual percentage change.

^ indicates the APC is significantly different from zero at p = 0.05

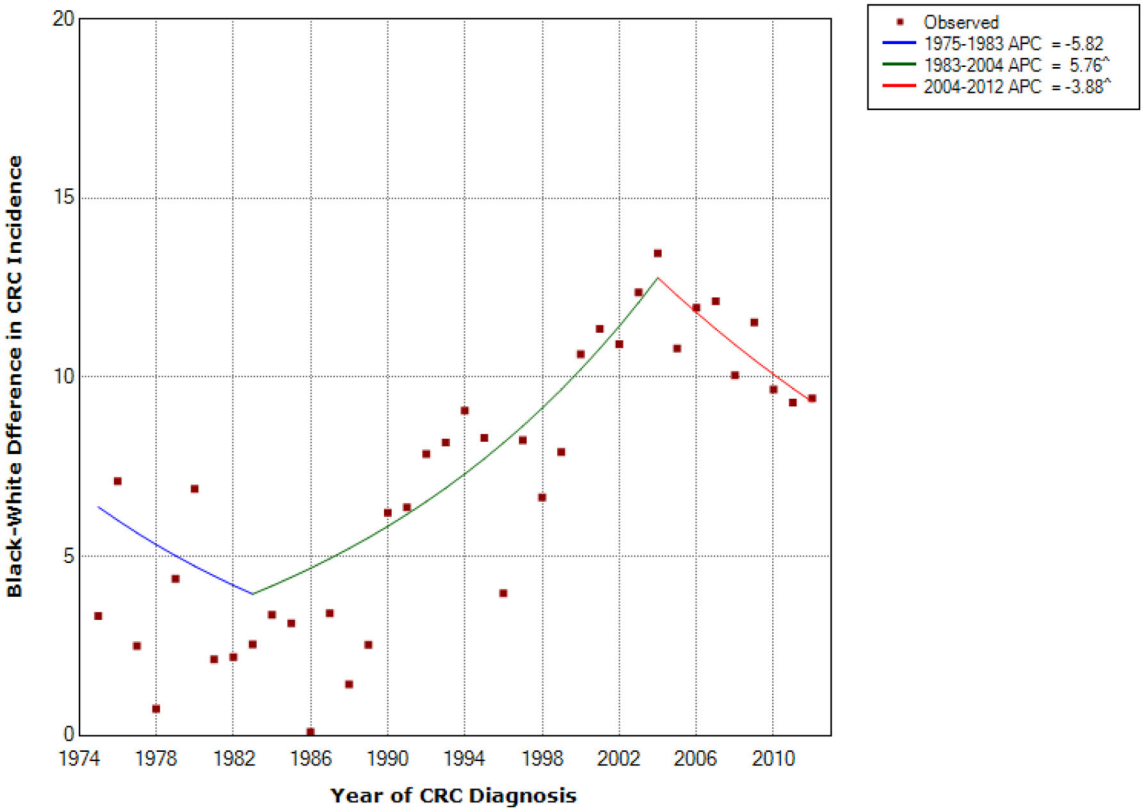

Figure 2.

Evaluation for significant trends in the absolute difference in CRC incidence between whites and blacks; SEER 9 (1975–2011)*

*Observed difference is defined as the absolute difference in the incidence in whites and the incidence in blacks for a given year. APC indicates annual percentage change.

^ indicates the APC is significantly different from zero at p = 0.05

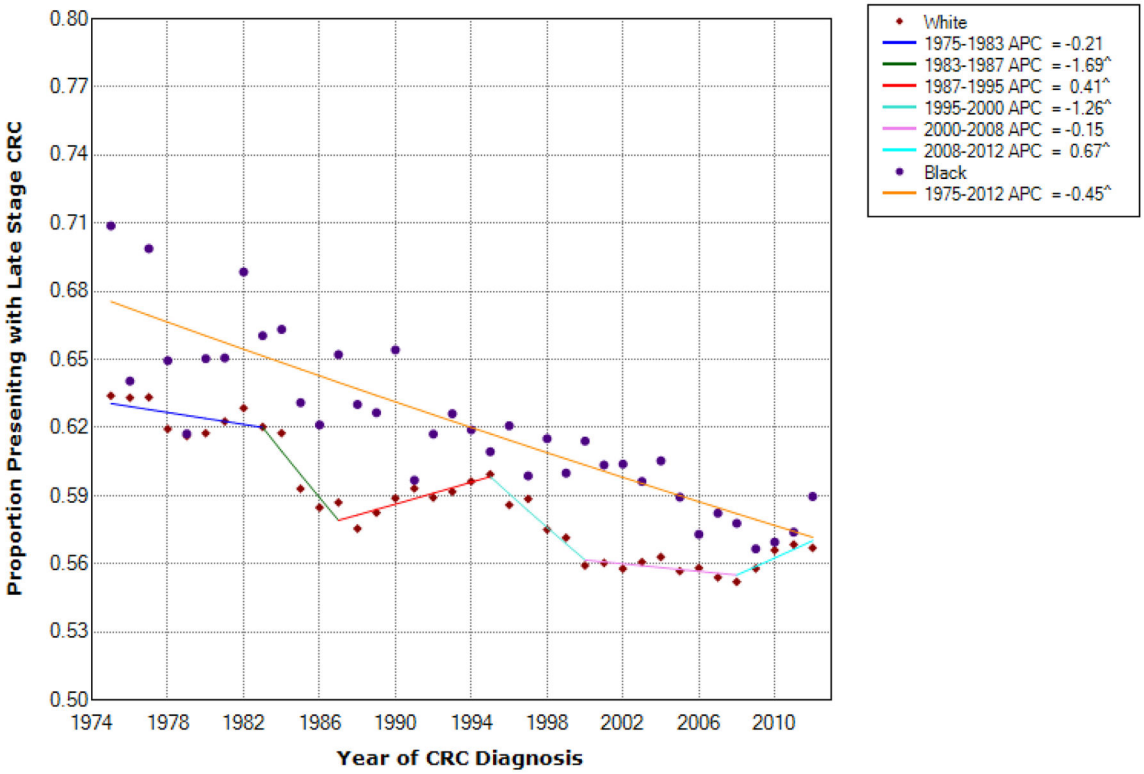

Figure 3.

Evaluation for significant linear trends in late stage CRC presentation in whites and blacks; SEER 9 (1975–2011)*

*APC indicates annual percentage change.

^ indicates the APC is significantly different from zero at p = 0.05.

Table 1

Colorectal cancer (CRC) incidence and stage at presentation by race; 1975–2012; SEER 9

	Age-Adjusted Incidence		
	Whites	**Blacks**	**Total**
Incidence^, N (cases per 100,000)	398,466 (54.45)	41,698 (60.22) *	440, 144 (55.1)
Stage at Presentation, N (%) +			
Early	154,543 (38.79)	14,824 (35.55) *	169,367 (38.48)
Late	218,385 (54.81)	23,853 (57.20) *	242,238 (55.04)
Unstaged	25,518 (6.40)	3,021 (7.24)	28,539 (6.48)

+ For stage %, denominator is total CRC cases for each race group

^ Incidence rates are age-adjusted to the 2000 U.S. standard population.

* Statistically different than white at p<0.001