INCIDENCE AND SURVIVAL OF EARLY ONSET CANCERS IN CALIFORNIA, 2006-2021

UC DAVIS HEALTH | COMPREHENSIVE CANCER CENTER

ACKNOWLEDGEMENTS AND DISCLAIMER

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EXECUTIVE SUMMARY

GENERAL AND CROSS-CUTTING FINDINGS

- Early onset cancer burden increased in California during 2006-2021, with disparities in incidence and relative survival by age at diagnosis, race/ethnicity, and sex.
- The cancers with the highest incidence of early onset cancer from 2017-2021 were female breast (73.8 per 100,000), thyroid (14.6 per 100,000), testicular (12.1 per 100,000), uterine (11.8 per 100,000), and colorectal (11.4 per 100,000).
- The incidence of each of the 5 most common early onset cancers increased during 2006-2021. The greatest increase in incidence was observed for uterine, followed by thyroid, colorectal, testicular, and female breast cancers.
- Incidence among Hispanic individuals and those diagnosed at stage I increased during the study period for each of the 5 most common early onset cancers.
- Nearly 80 percent of early onset cancers diagnosed in 2006-2021 were among females, driven by female breast and thyroid cancers.

FEMALE BREAST CANCER

- The highest incidence was among females 40-49 years, of Asian/Pacific Islander (API) race, and who were diagnosed at stage I.
- Incidence increased during the study period among females 20-49 years, of API or Hispanic race/ethnicity, and who were diagnosed at stages I and IV.
- The lowest 5-year relative survival for females diagnosed during 2014-2021 was among those aged 20-29 years and of non-Hispanic (NH) Black or Hispanic race/ethnicity. Relative survival improved over the study period for those diagnosed at stage IV.

THYROID CANCER

- Although incidence increased during 2006-2011, incidence remained stable during 2012-2021.
- The incidence of early onset thyroid cancer in 2021 in California was highest among individuals 40-49 years, of API race, who were diagnosed at stage I, and who were females.
- Incidence increased during the study period among individuals 20-49 years, of Hispanic or NH White race/ethnicity, and who were diagnosed at stage I.
- The 5-year relative survival for individuals diagnosed during 2014-2021 was above 98 percent for every race/ethnicity. The lowest survival was experienced by individuals 40-49 years, of NH Black race/ethnicity, who were diagnosed at stage IV, and who were male.

COLORECTAL CANCER

- Incidence in 2021 was the highest among individuals 40-49 years, of NH Black race/ethnicity, who were diagnosed at stage III, and who were males.
- Over the study period, incidence increased among individuals 30-49 years, of Hispanic or NH White race/ethnicity, and who were diagnosed at stages I, III, and IV.
- The lowest 5-year relative survival for individuals diagnosed during 2014-2021 was among those of NH Black race/ethnicity, who were diagnosed at stage IV, and who were males.
- The 5-year relative survival increased over the study period for individuals diagnosed at stages III and IV.

TESTICULAR CANCER

- Incidence in 2021 was highest among males 30-39 years, of Hispanic ethnicity, and who were diagnosed at stage I.
- Over the study period, incidence increased among males 20-39 years, of API or Hispanic race/ethnicity, and who were diagnosed at stage I.
- The 5-year relative survival among males diagnosed during 2014-2021 was lowest among those 20-29 years and of NH Black race/ethnicity.

UTERINE CANCER

- Subgroups with the highest incidence in 2021 included females 40-49 years, of Hispanic ethnicity, and who were diagnosed at stage I.
- Over the study period, incidence increased among females 20-49 years, of API or Hispanic race/ethnicity, and who were diagnosed at stages I, III, and IV.
- The lowest 5-year relative survival for females diagnosed during 2014-2021 was among those 20-29 years, of NH Black race/ethnicity, and who were diagnosed at stage IV.

INTRODUCTION

While overall cancer incidence in the United States has remained stable during the past decade, a disturbing trend has emerged among young adults. Incidence of early onset cancers among young adults aged 20-49 years has increased since the 1990s, with disparities observed by age, race/ethnicity, and sex[1-13]. Prior studies have observed an increasing trend in breast, gastrointestinal, testicular, and female genital cancers[1,2,4,14]. Increasing incidence of early onset cancer may be associated with increasing obesity, alcohol intake, antibiotic use, environmental exposures, and physical inactivity[1,15].

Young adults are a heterogenous group faced with a unique set of challenges. Compared to older adults, young adults historically have the lowest rate of health insurance coverage, despite increases following the implementation and expansion of the Affordable Care Act[16,17]. Prior research has identified racial/ethnic minorities, non-English-speaking, the least educated, and the lowest income earning young adults as the least likely to have health insurance[18]. However, even among patients with health insurance, the financial burden of copays, premiums, and costs not covered by insurance may lead to delayed or foregone cancer treatment[2,19].

Higher rates of late stage at cancer diagnosis have been reported among younger compared to older adults as they are less likely to regularly visit a primary care provider in the absence of troubling symptoms[2,20,21]. Recommended cancer screenings for young adults include cervical, breast, and colorectal cancer, beginning at ages 21, 40, and 45 years respectively[22-24]. However, screening rates tend to be lower in adults under 50 years of age compared to older[25,26]. One notable study found that uptake of colorectal cancer screening was less than 20 percent among adults aged 45-49[26].

The purpose of this report is to quantify the burden of early onset cancer in California as well as to identify disparities in incidence and survival. Information presented in this report was obtained by the California Cancer Registry (CCR), the state mandated population-based cancer surveillance system in operation since 1988. The CCR routinely collects demographic, diagnostic, and treatment information on cancer cases diagnosed in California, and has provided the foundation for research studies and cancer control initiatives throughout the state. Since 2012, the California Cancer Reporting and Epidemiologic Surveillance (CalCARES) Program, within the University of California Davis Comprehensive Cancer Center, has partnered with the California Department of Public Health in the management of day-to-day operations of the CCR.

METHODS

INCIDENCE

Incident cases of invasive early onset (ages 20 to 49 years) cancer diagnosed among male and female California residents during 2006 to 2021 and reported to CCR as of December 31st, 2023, were included in this report. Tumors were classified based on primary site and histology according to the International Classification of Diseases for Oncology, third edition[27]. Cases of breast cancers presented in the report are limited to female patients. Uterine cancer cases refer to both corpus uteri and uterus, NOS sites. Colorectal cancer cases exclude appendiceal tumors, which differ genetically and prognostically from colorectal tumors [2,28,29]. For sex-specific cancers, denominators included the population of the sex at risk.

AGE-ADJUSTED RATES

Age-adjusted incidence rates (AAIR) were calculated as the number of new cases (incidence) in specific age groups per 100,000 persons each year and were age-adjusted to the 2000 United States standard population. Age-adjusted rates are weighted averages of age-specific rates, where the weights represent the age distribution of a standard population. Such adjustment eliminates differences in rates due to changes in the age of a population over time, or due to differences in the age distribution between population groups. Rates in this report were calculated using the National Cancer Institute's Surveillance Research Program, SEER*Stat software version 8.4.5[30]. Minor changes in the number of cases within small populations can yield high variation in age-adjusted rates. Both AAIR and trend in AAIR were suppressed when based on counts less than 20, as unstable estimates may lead to spurious conclusions[31].

TRENDS IN CANCER INCIDENCE

Joinpoint linear regression was used to determine trends in early onset cancer incidence of female breast, thyroid, colorectal, testicular, and uterine cancers. In this analysis, a statistical algorithm detects "joinpoints", or points in time where the slope of the regression line significantly changes. Thus, the model describes trends during different time segments, with the annual percent change (APC) estimated for each segment. The Average Annual Percent Change (AAPC) is a summary measure of a trend over a pre-specified fixed interval. It allows the use of a single number to describe the average increase or decrease in rates over a period of multiple years. The AAPC is a valid measure even if there were changes in trends during the period considered. It is computed as a weighted average of the annual percent changes from the joinpoint model, with the weights equal to the length of the APC interval. The overall, or total percent change in rates during the period was calculated as 100*(1+AAPC/100)t -100, where t is the number of years in the period. Joinpoint version 5.3.0.0 software was used for all trend analyses[32]. If a joinpoint is not detected, the APC equals the AAPC. All age-adjusted trends exclude 2020 data, as Joinpoint software cannot accommodate one-year anomalies[33]. The AAIR of 2020, while not included in trend analyses, is pictured on all trend figures.

RELATIVE SURVIVAL

Five-year relative survival was estimated for patients diagnosed with early onset female breast, thyroid, testicular, uterine, and colorectal cancers during two distinct time periods of 2006-2013 and 2014-2021 by age at diagnosis, race/ethnicity, stage at diagnosis, and sex using SEER*Stat software version 8.4.5[34]. Relative survival is the quotient of the observed survival divided by the expected survival of a population and is a measure of the excess mortality of cancer patients compared to the general population[35]. Expected survival was calculated from U.S. life tables based on age, sex, and race/ethnicity. A relative survival of 100 percent indicates that cancer patients were just as likely as the general population of the same age, sex, and race/ethnicity to survive five years. If the estimated relative survival is greater than 100 percent, confidence intervals cannot be calculated[36].

RACE/ETHNICITY

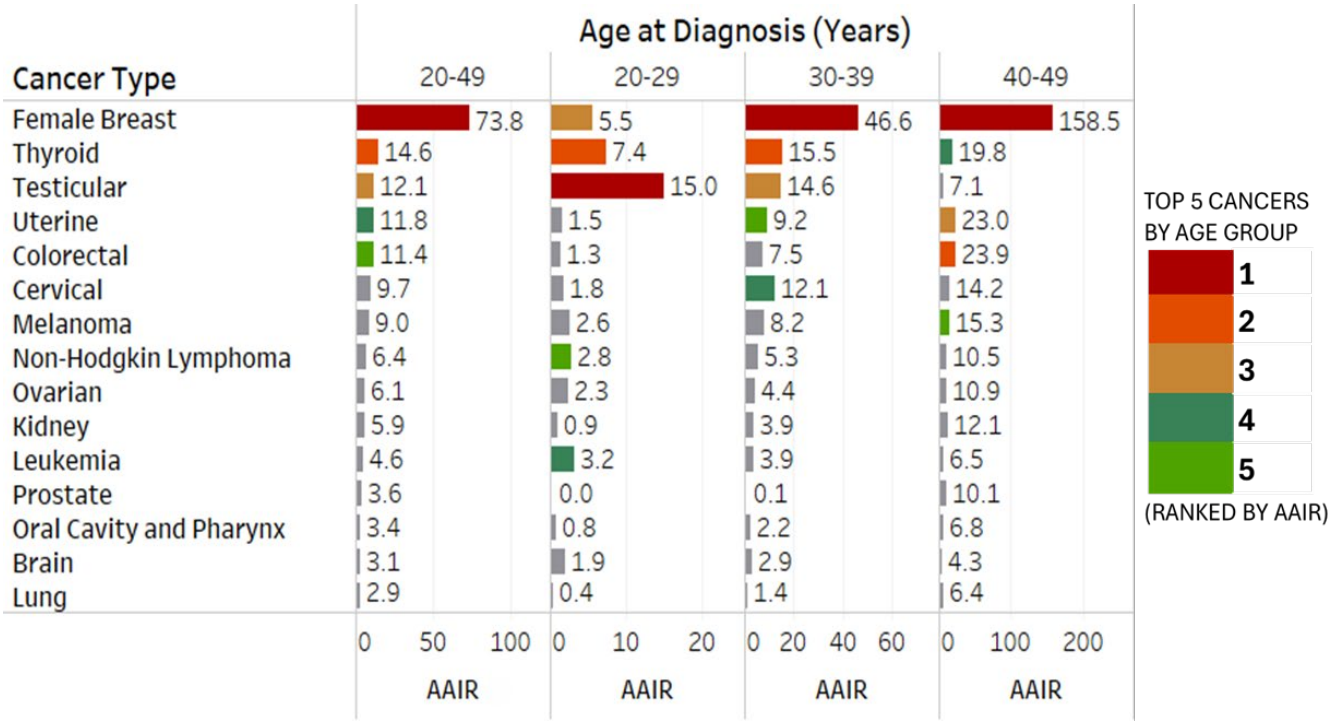
Race/ethnicity was grouped into the mutually exclusive categories of Asian/Pacific Islander (API), Hispanic, non-Hispanic Black (NH Black), and non-Hispanic White (NH White). Race and ethnicity were reported as separate data items during data collection. Hispanic ethnicity and API race were assigned using the North American Association of Central Cancer Registries' Hispanic and Asian/Pacific Islander Identification Algorithm (NHAPIIA). NHAPIIA uses information on a person's race, birthplace, last name, and maiden name to determine Hispanic ethnicity or API race. Hispanic ethnicity may be assigned to individuals of any race. Persons reported as White or Black race and non-Hispanic ethnicity were classified as non-Hispanic White and Black, respectively.

STAGE AT DIAGNOSIS

Cancer stage at diagnosis was assigned according to the American Joint Committee on Cancer (AJCC) rules and presented as stages I, II, III, IV, and unknown[37-39]. Stage 0 (in-situ, non-invasive) tumors were excluded from this report. AJCC staging is based on the location, size, and extent of the primary tumor as well as lymph node involvement and presence of metastasis. Stage I tumors are confined to the primary site with no lymph node involvement. Stage II and III tumors have extended regionally and/or to regional lymph nodes. Stage IV tumors have distant metastisis.[40] According to AJCC, testicular cancer may be staged 0-III; stage III indicates distant cancer metastasis[41].

RESULTS

FIGURE 1. AGE-ADJUSTED INCIDENCE RATES OF THE 15 MOST COMMON EARLY ONSET CANCERS DIAGNOSED IN CALIFORNIA BY AGE GROUP, 2017-2021



- Among all young adults 20-49 years diagnosed with early onset cancer from 2017-2021 in California, female breast was the most common site (73.8 per 100,000), followed by thyroid (14.6 per 100,000), testicular (12.1 per 100,000), uterine (11.8 per 100,000), and colorectal (11.4 per 100,000) cancers.
- The most common incident cancer among individuals 20-29 years was testicular (15.0 per 100,0000), followed by thyroid (7.4 per 100,000), female breast (5.5 per 100,000), leukemia (3.2 per 100,000), and non-Hodgkin lymphoma (2.8 per 100,000).
- Among individuals 30-39 years, female breast was the most common incident cancer (46.6 per 100,000), followed by thyroid (15.5 per 100,000), testicular (14.6 per 100,000), cervical (12.1 per 100,000), and uterine (9.2 per 100,000) cancers.
- Female breast was the most common incident cancer among those ages 40-49 years (158.5 per 100,000), followed by colorectal (23.9 per 100,000), uterine (23.0 per 100,000), thyroid (19.8 per 100,000), and melanoma (15.3 per 100,000).

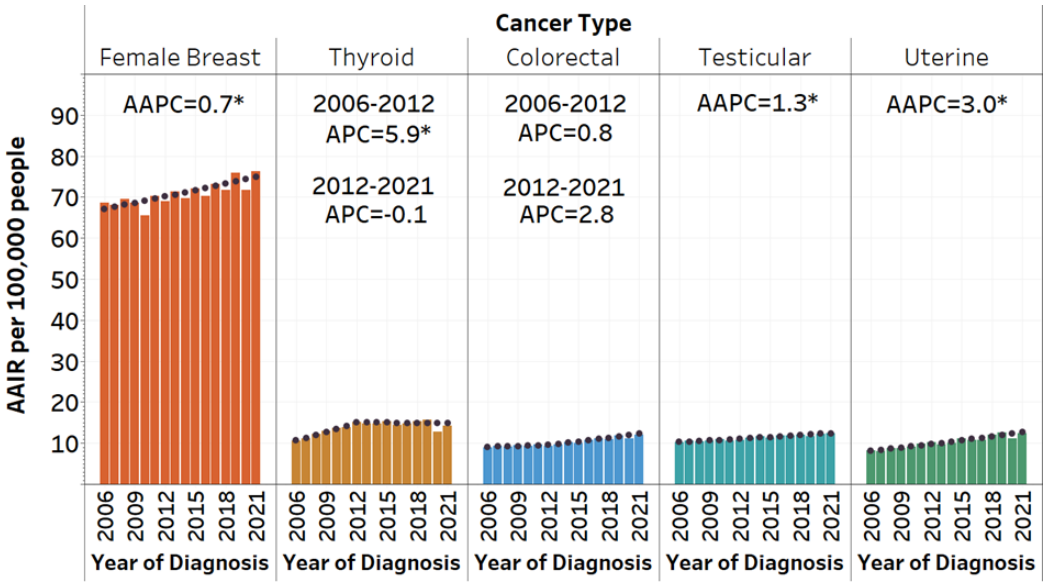
TABLE 1. CHARACTERISTICS OF PATIENTS DIAGNOSED WITH THE TOP 5 INCIDENT EARLY ONSET CANCERS IN CALIFORNIA, 2006-2021

	Total (171,493)		Female Breast (84,367)		Thyroid (34,697)		Colorectal (24,773)		Testicular (15,395)		Uterine (12,261)	
Characteristic	N	%	n	%	n	%	n	%	n	%	n	%
Year of Diagnosis												
2006-2013	81,808	47.7	41,604	49.3	16,152	46.6	11,463	46.3	7,070	45.9	5,519	45.0
2014-2021	89,685	52.3	42,763	50.7	18,545	53.5	13,310	53.7	8,325	54.1	6,742	55.0
Sex												
Male	35,499	20.7	—	—	6,858	19.8	13,246	53.5	15,395	100.0	—	—
Female	135,994	79.3	84,367	100.0	27,839	80.2	11,527	46.5	—	—	12,261	100.0
Age at Diagnosis (Years)												
20-29	17,146	10.0	2,338	2.8	6,465	18.6	1,154	4.7	6,613	43.0	576	4.7
30-39	45,134	26.3	18,075	21.4	12,640	36.4	5,453	22.0	5,818	37.8	3,148	25.7
40-49	109,213	63.7	63,954	75.8	15,592	44.9	18,166	73.3	2,964	19.3	8,537	69.6
Race/Ethnicity												
API	29,593	17.3	16,060	19.0	6,156	17.7	4,006	16.2	875	5.7	2,496	20.4
Hispanic	56,838	33.1	24,735	29.3	12,139	35.0	8,157	32.9	6,578	42.7	5,229	42.7
NH Black	9,187	5.4	5,567	6.6	1,072	3.1	1,784	7.2	263	1.7	501	4.1
NH White	72,512	42.3	36,695	43.5	14,587	42.0	10,324	41.7	7,141	46.4	3,765	30.7
Other/Unknown	3,363	2.0	1,310	1.6	743	2.1	323	2.0	538	3.5	270	2.2
Stage at Diagnosis												
I	88,126	51.4	34,938	41.4	30,594	88.2	3,976	16.1	10,207	66.3	8,411	68.6
II	36,006	21.0	28,099	33.3	1,012	2.9	4,562	18.4	1,720	11.2	613	5.0
III	23,870	13.9	11,641	13.8	1,376	4.0	7,546	30.5	2,221	14.4	1,086	8.9
IV	12,716	7.4	4,535	5.4	874	2.5	6,477	26.2	—	—	830	6.8
Unstaged/Unknown	10,775	6.3	5,154	6.1	841	2.4	2,212	8.9	1,247	8.1	1,321	10.8

- Of 171,493 early onset cancers diagnosed during 2006-2021 in California, female breast cancer was the most common (84,367 cases), followed by thyroid (34,697 cases), colorectal (24,773 cases), testicular (15,395 cases), and uterine (12,261 cases) cancers.
- Nearly 80 percent of early onset cancers were diagnosed among females. This was driven primarily by female breast cancer. However, females also comprised 80 percent of thyroid cancers (27,839 cases). Among males, testicular cancer was the most common site, with 15,395 diagnoses.

- Early onset cancers were the most common among ages 40-49 (63.7 percent), followed by 30-39 years (26.3 percent), and 20-29 years (10.0 percent).
- NH White patients comprised the majority of early onset cancer diagnoses (42.3 percent), followed by Hispanic (33.1 percent), API (17.3 percent), and NH Black (5.4 percent) patients. Among all race/ethnicities, breast cancer was the most common site of early onset cancer, followed by thyroid and colorectal cancers among API, Hispanic, and NH White patients. Among NH Black patients, colorectal cancer was the second most common cancer followed by thyroid cancer.
- Most early onset cancers diagnosed during the study period were diagnosed at stage I (51.4 percent), followed by stage II (21 percent), stage III (13.9 percent), stage IV (7.4 percent), and unknown stage (6.3 percent). While female breast, thyroid, testicular, and uterine cancers were most commonly diagnosed at stage I, colorectal cancers were most commonly diagnosed at stage III (30.5 percent), followed by stage IV (26.2 percent), stage II (18.4 percent), and stage I (16.1 percent).

FIGURE 2. TRENDS IN AGE-ADJUSTED INCIDENCE RATES OF THE MOST COMMON INCIDENT EARLY ONSET CANCERS DIAGNOSED IN CALIFORNIA, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

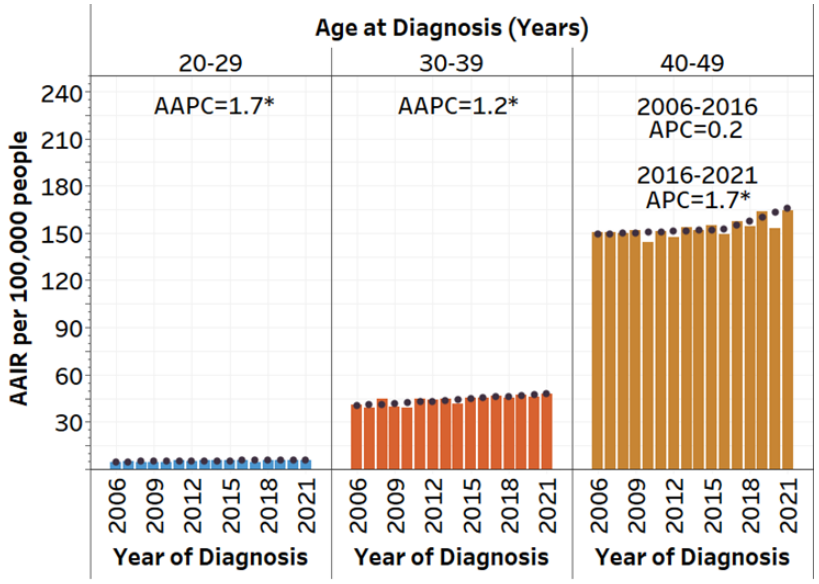
- Uterine (by 3 percent per year), testicular (by 1.3 percent per year), and female breast (by 0.7 percent per year) cancers increased during 2006-2021. Although colorectal cancer increased by 2 percent per year overall, neither increasing trend during 2006-2012 nor 2012-2021 reached statistical significance. Thyroid cancer incidence increased by 5.9 percent per year during 2006-2012, then was stable during 2012-2021.
- In 2021, the incidence rate of early onset cancer was highest for female breast cancer (76.3 per 100,000), followed by thyroid (14.2 per 100,000), uterine (12.7 per 100,000), testicular (12.4 per 100,000), and colorectal (12.1 per 100,000) cancers.

FEMALE BREAST CANCER

Early onset female breast cancer incidence in California increased by 0.7 percent per year during 2006-2021 with disparities by age at diagnosis and race/ethnicity. Subgroups with the highest incidence in 2021 included females 40-49 years (164.5 per 100,000), of API race (90.2 per 100,000), and who were diagnosed at stage I (45.1 per 100,000). Females of Hispanic ethnicity had the lowest incidence in 2021 (60.1 per 100,000). Incidence increased among all ages and race/ethnicities during the study period, except NH Black individuals. The incidence among females of NH Black race/ethnicity declined by 1.2 percent per year. The incidence of females with stage I and IV diagnosis increased over the study period, while stage II and III incidence decreased.

Five-year relative survival improved from 2006-2013 to 2014-2021 among those diagnosed at stage IV (38.6 to 43.9 percent). The lowest 5-year relative survival rate was experienced by the youngest patients, aged 20-29 years (83.3 percent), NH Black (81.5 percent) and Hispanic (87.4 percent) patients, and those diagnosed at stage IV (43.9 percent).

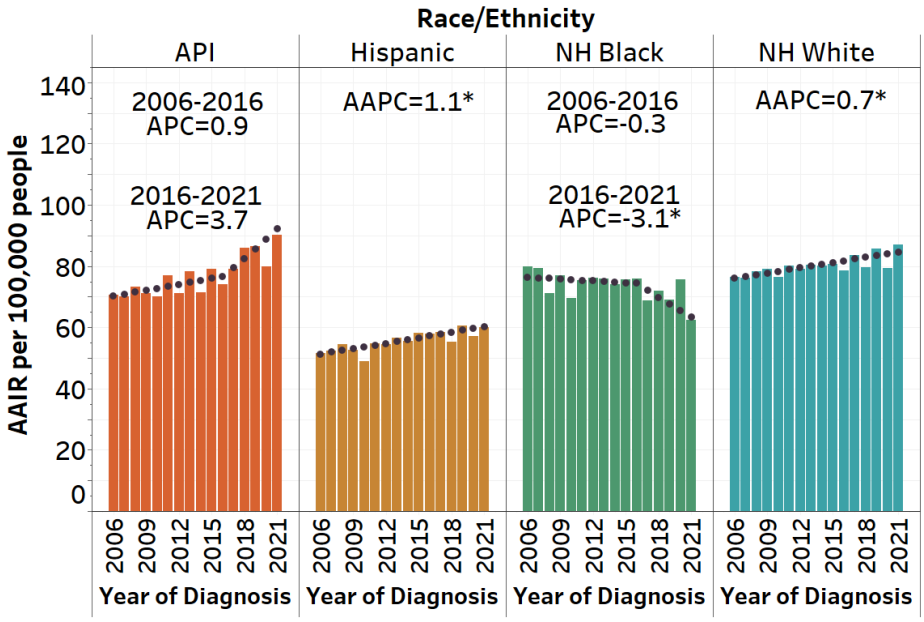
FIGURE 3. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET FEMALE BREAST CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

- During the study period, the incidence of early onset female breast cancer increased among those 20-29 (1.7 percent per year) and 30-39 (1.2 percent per year) years.
- Among females 40-49 years, rates were stable during 2006-2016, then increased by 1.7 percent per year during 2016-2021.

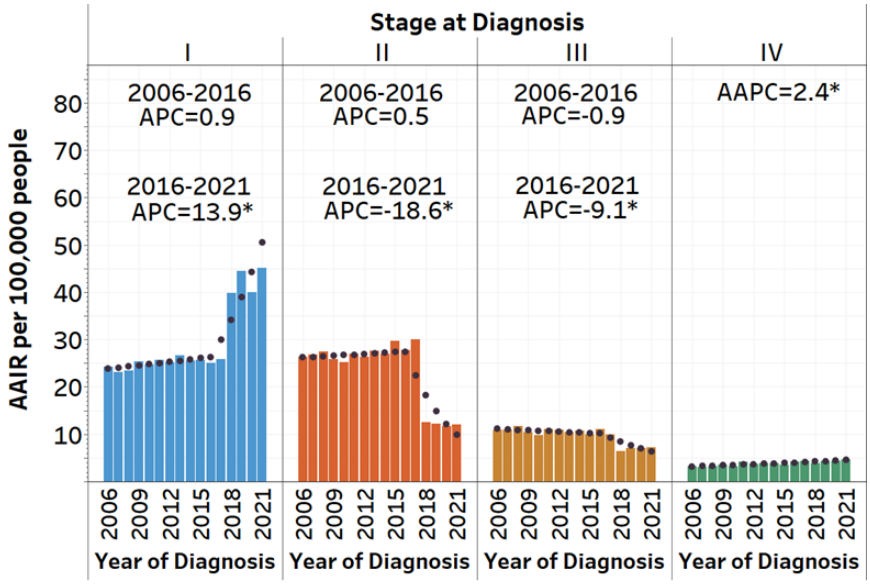
FIGURE 4. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET FEMALE BREAST CANCER IN CALIFORNIA BY RACE/ETHNICITY, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

- Incidence increased among Hispanic (1.1 percent per year) and NH White (0.7 percent per year) females during 2006-2021.
- Neither the increasing trend in API incidence during 2006-2016 nor 2016-2021 reached statistical significance.
- The incidence among NH Black individuals was stable during 2006-2016 before declining by 3.1 percent per year during 2016-2021.

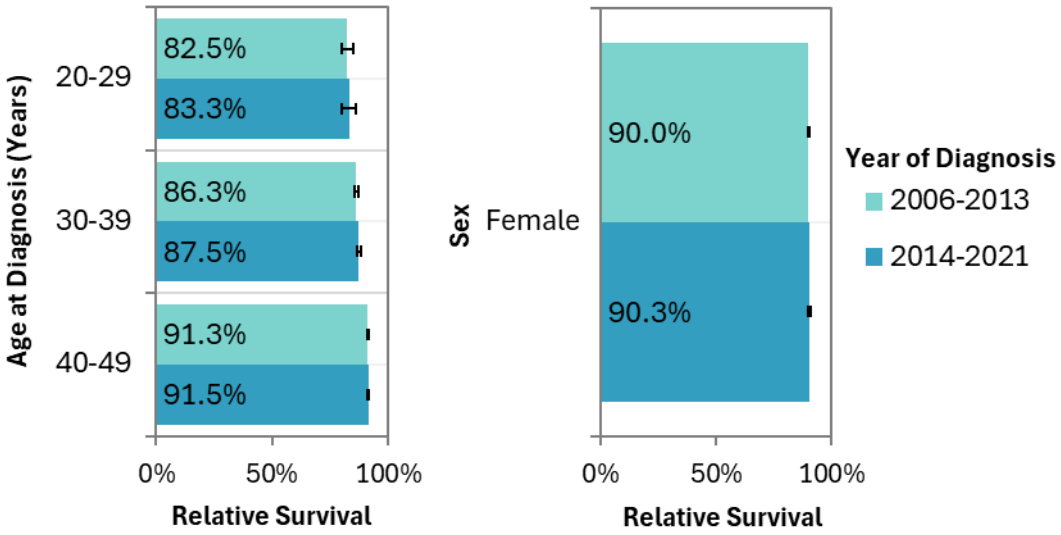
FIGURE 5. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET FEMALE BREAST CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

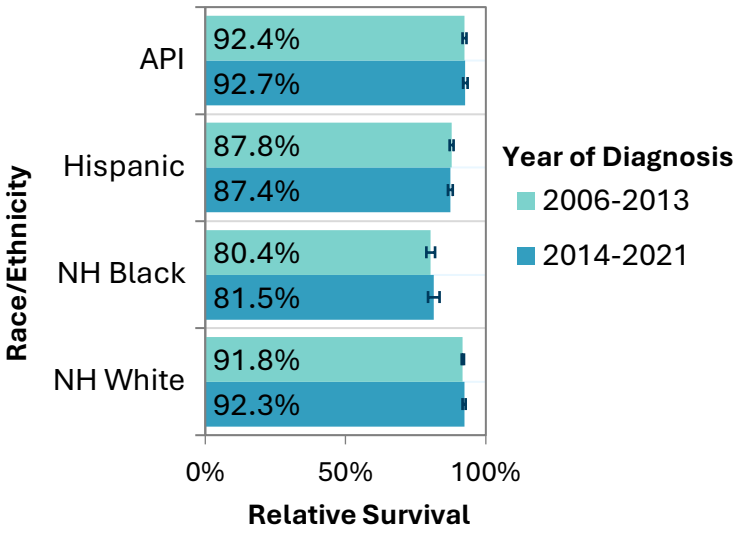
- Incidence was stable among those diagnosed at stage I during 2006-2016 before increasing by 14 percent per year during 2016-2021.
- Stage II incidence was stable during 2006-2016 before decreasing by 18.6 percent per year during 2016-2021.
- Likewise, stage III incidence was stable during 2006-2016 before decreasing by 9.1 percent per year during 2016-2021.
- Over the study period, the incidence of early onset female breast cancer increased for those diagnosed at stage IV (2.4 percent per year).

FIGURE 6. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET FEMALE BREAST CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS AND SEX 2006-2013 AND 2014-2021



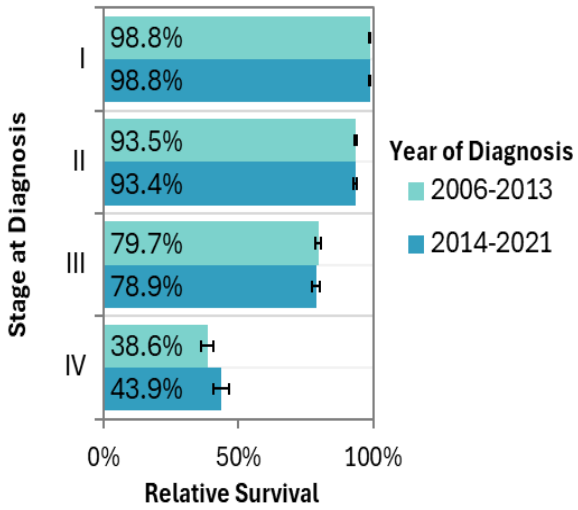
- Among females diagnosed during 2014-2021, those aged 40-49 years had the highest 5-year relative survival after early onset female breast cancer, followed by females 30-39 and 20-29 years. The estimated relative survival for each age group was similar in the two time periods.
- 5-year relative survival was stable across the two time periods.

FIGURE 7. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET FEMALE BREAST CANCER IN CALIFORNIA BY RACE/ETHNICITY 2006-2013 AND 2014-2021



- For those diagnosed during 2014-2021, the highest 5-year relative survival for early onset female breast cancer was among API, followed by NH White, Hispanic, and NH Black patients.

FIGURE 8. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET FEMALE BREAST CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS 2006-2013 AND 2014-2021



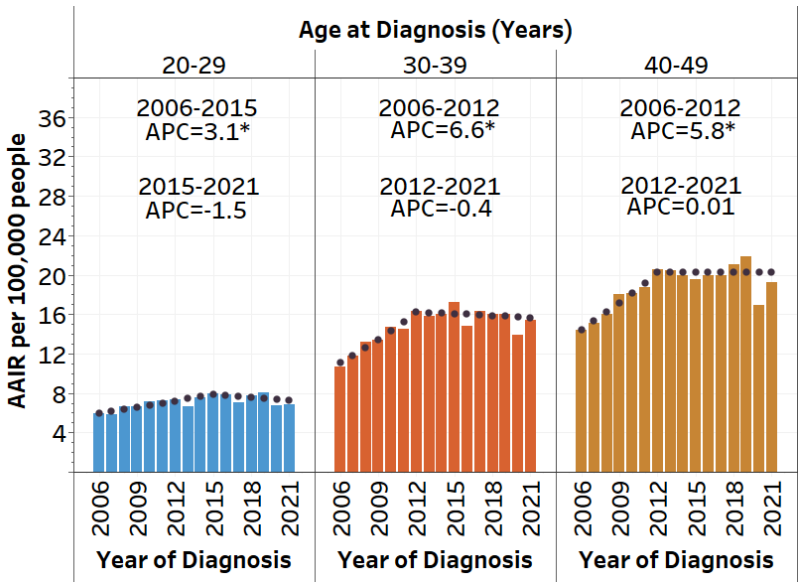
- Females diagnosed at stage I during 2014-2021 experienced the highest 5-year relative survival after early onset female breast cancer, followed by those diagnosed at stages II, III, and IV.
- The relative survival of females diagnosed at stage IV improved from 2006-2013 to 2014-2021 (38.6 to 43.9 percent).

THYROID CANCER

The incidence of early onset thyroid cancer in California increased by nearly six percent per year during 2006-2012, then remained stable during 2012-2021. Rates were stable after 2015 for individuals aged 20-29 years and after 2012 for those aged 30-49 years. Similarly, the incidence increased early in the study period for subgroups including Hispanic and API individuals, and those diagnosed at stage I before stabilizing in the latter years of the study period. Among NH White patients, incidence decreased by 2.1 percent per year during 2012-2021. Subgroups with the highest incidence in 2021 included those aged 40-49 years at diagnosis (19.2 per 100,000), API individuals (16.6 per 100,000), individuals diagnosed at stage I (13.8 per 100,000), and females (23.1 per 100,000). The lowest incidence in 2021 was observed among NH Black (7.0 per 100,000) and male (5.6 per 100,000) individuals.

The 5-year relative survival of early onset thyroid cancer for patients diagnosed in California from 2014-2021 was lowest among individuals diagnosed at 40-49 years of age (99.2 percent), NH Black (98.1 percent) individuals, and those diagnosed at stage IV (87.6 percent). The 5-year relative survival for patients diagnosed during the two time periods was similar.

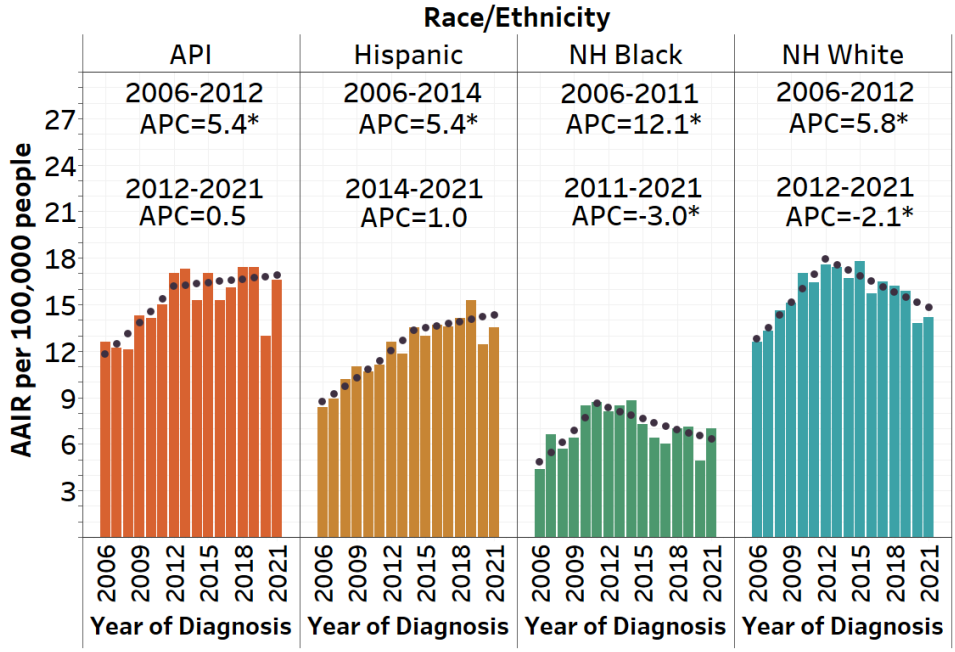
FIGURE 9. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET THYROID CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

- Among those aged 20-29 years, incidence increased by 3.1 percent per year during 2006-2015, then was stable during 2015-2021.
- Among those aged 30-39 years, incidence increased by 6.6 percent per year during 2006-2012, then was stable during 2012-2021.
- Among those aged 40-49 years, incidence increased by 5.8 percent per year during 2006-2012, then was stable during 2012-2021.

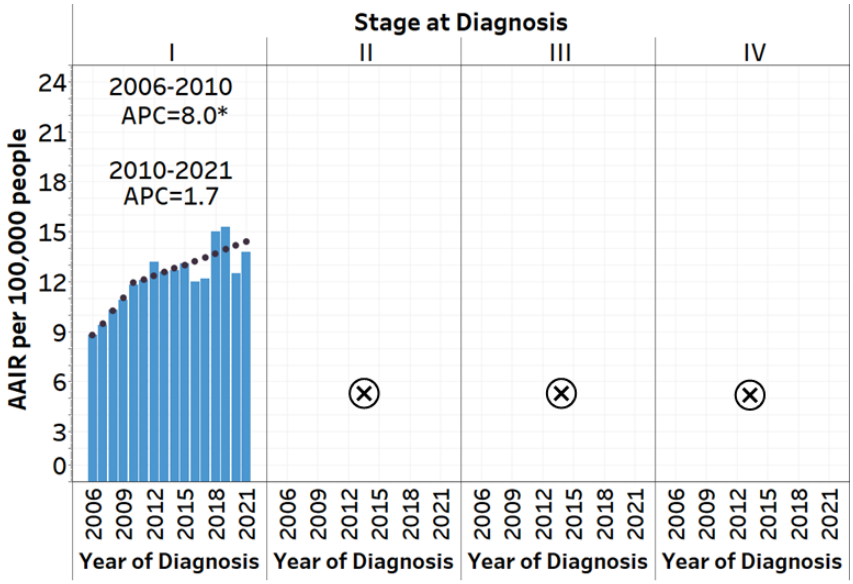
FIGURE 10. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET THYROID CANCER IN CALIFORNIA BY RACE/ETHNICITY, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

- Among API individuals, incidence increased by 5.4 percent per year during 2006-2012 then was stable during 2012-2021.
- Among Hispanic individuals, incidence increased 5.4 percent per year during 2006-2014, then was stable during 2014-2021.
- Among NH Black individuals, incidence increased by 12.1 percent per year during 2006-2011, then decreased by three percent per year during 2011-2021.
- Among NH White individuals, incidence increased by 5.8 percent per year during 2006-2012, then decreased by 2.1 percent per year during 2012-2021.

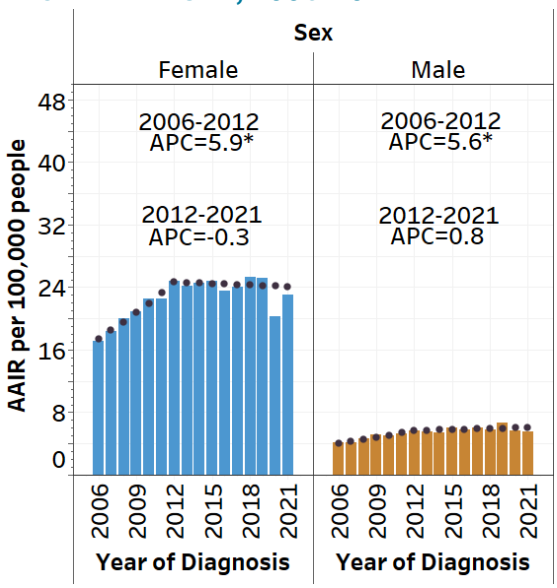
FIGURE 11. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET THYROID CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*
⊗Results based on annual counts less than 20 have been suppressed.

- The incidence of stage I thyroid cancer increased by 8.0 percent per year during 2006-2010. During 2010-2021, the increasing trend in incidence did not reach statistical significance.

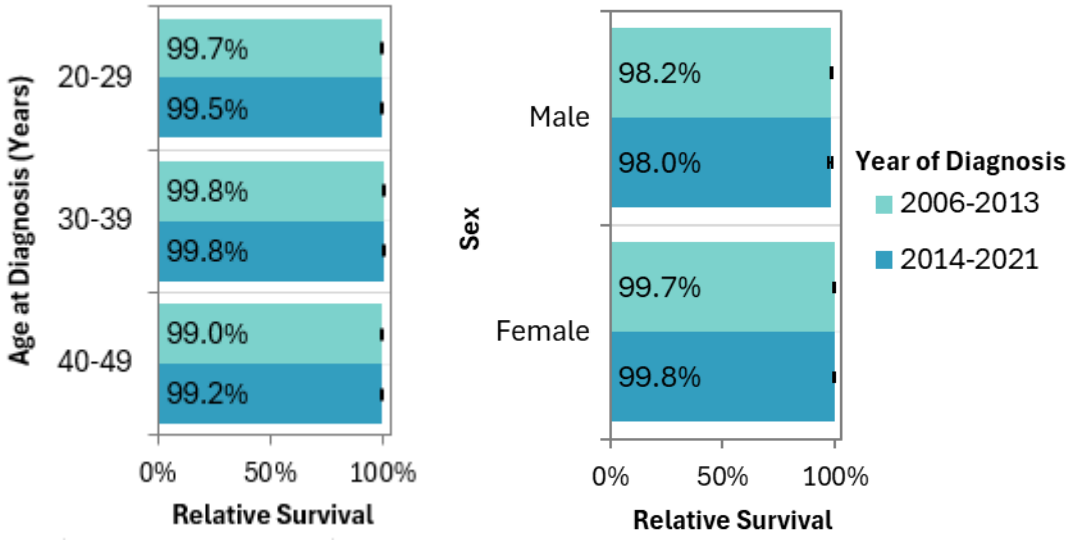
FIGURE 12. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET THYROID CANCER IN CALIFORNIA BY SEX, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

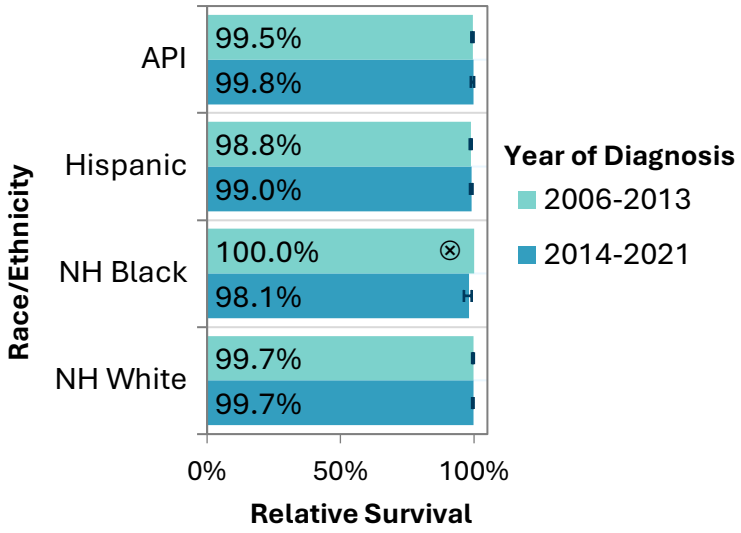
- Among females, incidence increased by 5.9 percent per year during 2006-2012, then remained stable during 2012-2021.
- Among males, incidence increased by 5.6 percent per year during 2006-2012, then remained stable during 2012-2021.

FIGURE 13. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET THYROID CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS AND SEX 2006-2013 AND 2014-2021



- In both study periods, the relative survival of early onset thyroid cancer was 99.0 percent or higher in all age groups. The estimated relative survival for each age group was similar in the two time periods.
- Females had slightly higher 5-year relative survival than males during both time periods. The estimated 5-year relative survival for both females and males was similar in the two time periods.

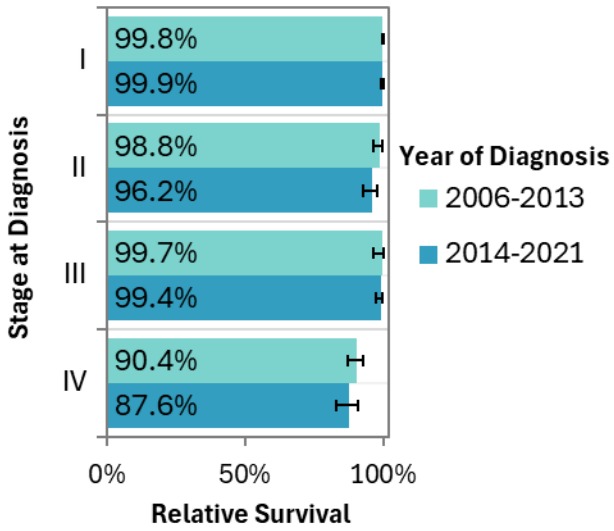
FIGURE 14. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET THYROID CANCER IN CALIFORNIA BY RACE/ETHNICITY 2006-2013 AND 2014-2021



⊗ Relative survival is greater than 100% - unable to calculate 95% CI.

- The 5-year relative survival of early onset thyroid cancers diagnosed during 2014-2021 was above 98 percent across all race/ethnicities. The highest rate was among NH White individuals at 99.7 percent, while the lowest was among NH Black individuals at 98.1 percent.
- The relative survival for each race/ethnicity was similar in the two time periods.

FIGURE 15. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET THYROID CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS 2006-2013 AND 2014-2021



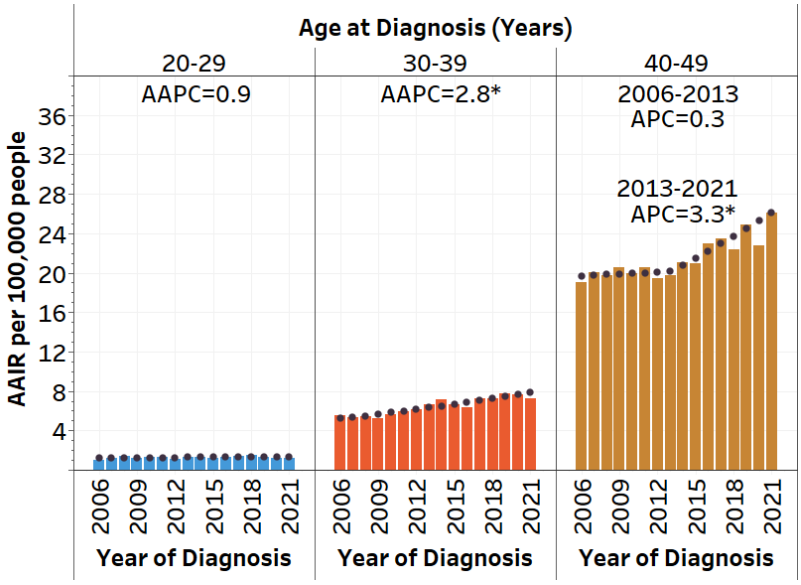
- Among patients diagnosed during 2014-2021, the highest 5-year relative survival was among those diagnosed at stage I, followed by stages III, II, and IV.
- The relative survival for each stage at diagnosis was similar in the two time periods.

COLORECTAL CANCER

Early onset colorectal cancer incidence in California increased during 2006-2021, with disparities by age at diagnosis, race/ethnicity, stage at diagnosis, and sex. Subgroups with increasing incidence over the study period included individuals who were 30-49 years, of NH White or Hispanic race/ethnicity, and diagnosed at stage I, III, and IV. Subgroups with the highest incidence of early onset colorectal cancer in 2021 included individuals 40-49 years (26.5 per 100,000), of NH Black race (13.6 per 100,000), diagnosed at stage III (3.6 per 100,000), and males (12.5 per 100,000). The incidence in 2021 was lowest among individuals of API race (11.1 per 100,000) and Hispanic ethnicity (11.2 per 100,000).

The 5-year relative survival of early onset colorectal cancer increased from 2006-2013 to 2014-2021 among individuals diagnosed at stages III (from 75.8 to 80.1 percent) and IV (from 17.8 to 21.3 percent). Subgroups with the lowest 5-year relative survival from 2014-2021 included those ages 20-29 (61.2 percent), NH Black (63.2 percent) and Hispanic individuals (63.3 percent), those diagnosed at stage IV (21.3 percent), and males (65.8 percent).

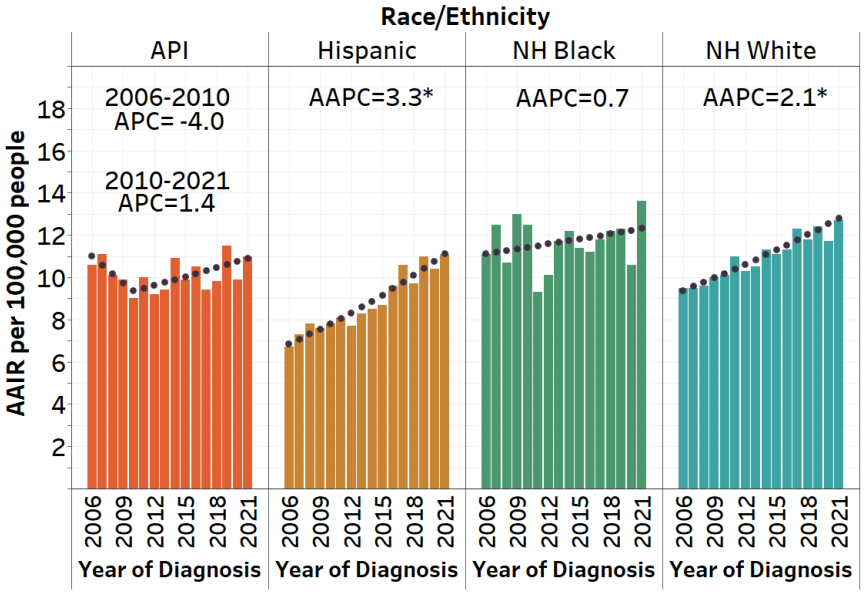
FIGURE 16. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET COLORECTAL CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

- Incidence rates were stable over the study period among individuals 20-29 years.
- During the study period, incidence increased among individuals 30-39 years (2.8 percent per year).
- Among individuals 40-49 years, incidence was stable during 2006-2013, then increased by 3.3 percent per year during 2013-2021.

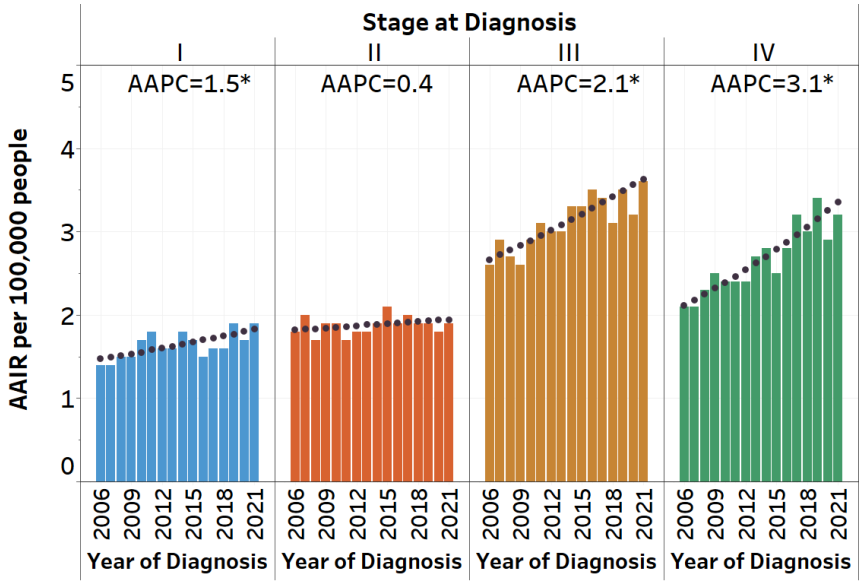
FIGURE 17. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET COLORECTAL CANCER IN CALIFORNIA BY RACE/ETHNICITY, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

- Over the study period, incidence increased among Hispanic (3.3 percent per year) and NH White (2.1 percent per year) individuals.
- Trends in incidence among API and NH Black individuals did not reach statistical significance over the study period.

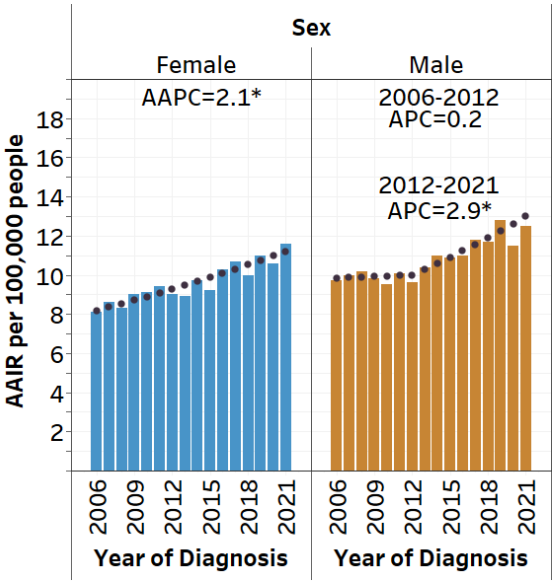
FIGURE 18. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET COLORECTAL CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

- Over the study period, incidence increased for those diagnosed at stages I (1.5 percent per year), III (2.1 percent per year), and IV (3.1 percent per year).
- Incidence among individuals diagnosed at stage II was stable over the study period.

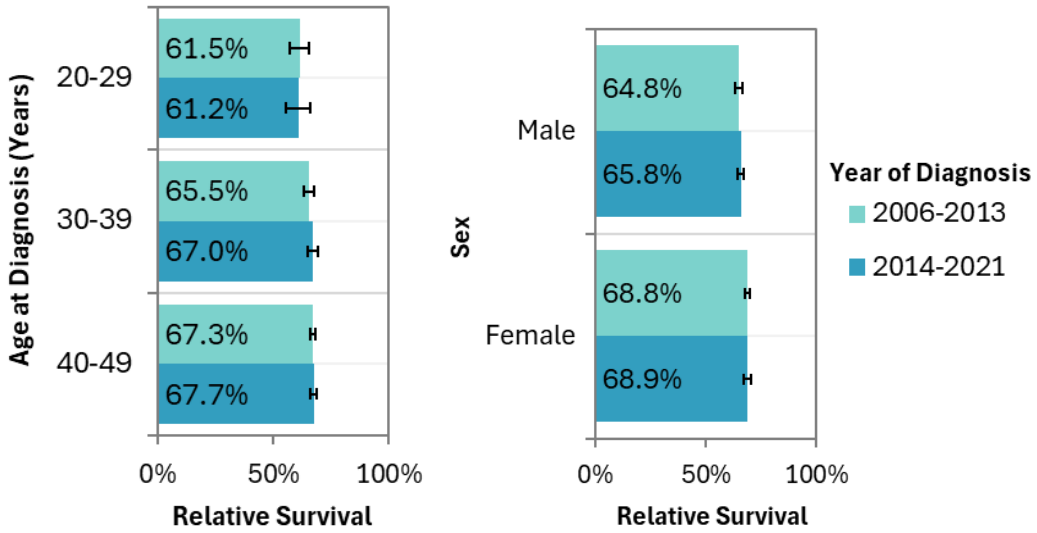
FIGURE 19. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET COLORECTAL CANCER IN CALIFORNIA BY SEX, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

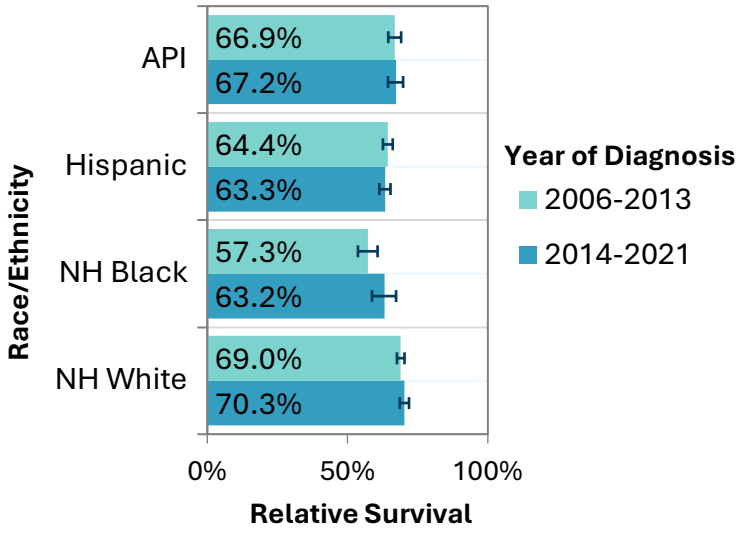
- Over the study period, incidence increased among females by 2.1 percent per year.
- Incidence rates were stable among males during 2006-2012, then increased by 2.9 percent per year during 2012-2021.

FIGURE 20. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET COLORECTAL CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS AND SEX 2006-2013 AND 2014-2021



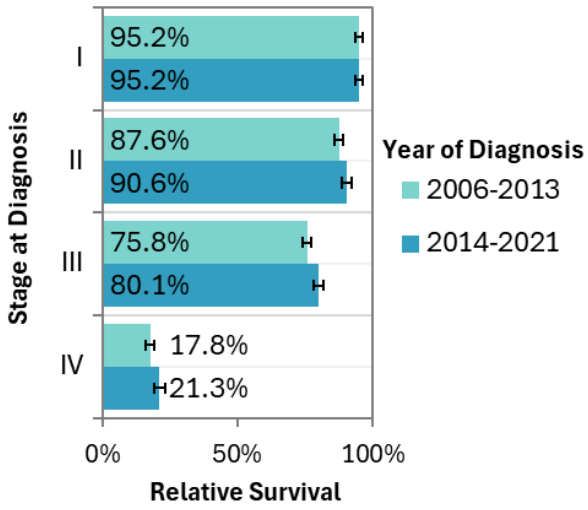
- In both study periods, individuals 40-49 years had the highest 5-year relative survival of early onset colorectal cancer, followed by those 30-39 and 20-29 years. The estimated relative survival for each age group was similar in the two time periods.
- In both study periods, females had higher 5-year relative survival than males. The estimated 5-year relative survival for females and males was similar in the two time periods.

FIGURE 21. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET COLORECTAL CANCER IN CALIFORNIA BY RACE/ETHNICITY 2006-2013 AND 2014-2021



- For individuals diagnosed during 2014-2021, the highest 5-year relative survival was among NH Whites, followed by API, Hispanic, and NH Black individuals.
- The estimated relative survival for each race/ethnicity was similar in the two time periods.

FIGURE 22. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET COLORECTAL CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS 2006-2013 AND 2014-2021



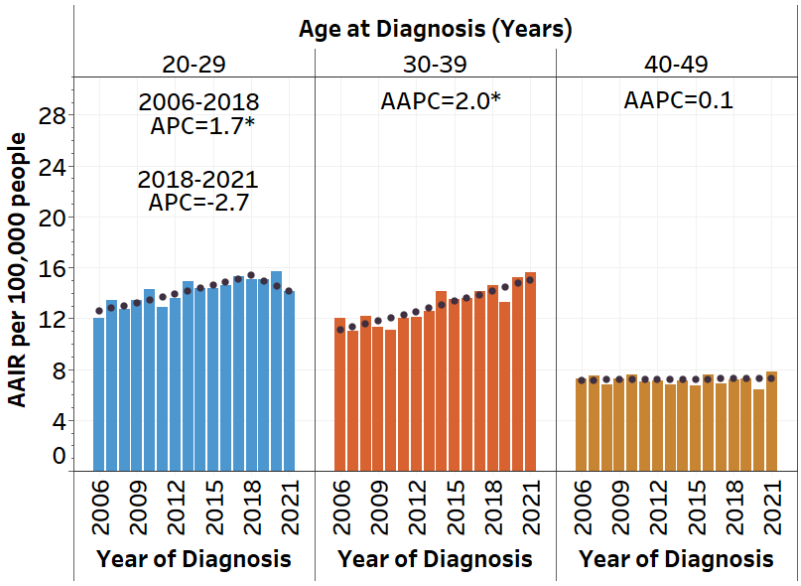
- In both study periods, individuals diagnosed at stage I experienced the highest 5-year relative survival after early onset colorectal cancer, followed by those diagnosed at stages II, III, and IV.
- 5-year relative survival improved from 2006-2013 to 2014-2021 among those diagnosed at stages III (75.8 to 80.1 percent) and IV (17.8 to 21.3 percent).

TESTICULAR CANCER

Early onset testicular cancer incidence in California increased by 1.3 percent per year during 2006-2021 with disparities by age at diagnosis and race/ethnicity. Subgroups with increasing incidence over the study period included those aged 20-39 years at diagnosis, API and Hispanic individuals, and those diagnosed at stage I. Those with the highest incidence of early onset testicular cancer in California in 2021 included males 30-39 years (15.6 per 100,000), of Hispanic ethnicity (14.8 per 100,000), and diagnosed at stage I (8.1 per 100,000). The incidence was the lowest among individuals 40-49 years (7.8 per 100,000) and of API race (4.5 per 100,000).

Subgroups diagnosed from 2014-2021 that experienced the lowest 5-year relative survival included males aged 20-29 years at diagnosis (93.2 percent), NH Black males (86.7 percent) and males diagnosed at stage III (72.5 percent). Five-year relative survival rates were similar among males diagnosed during 2006-2013 and 2014-2021.

FIGURE 23. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET TESTICULAR CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS, 2006-2021

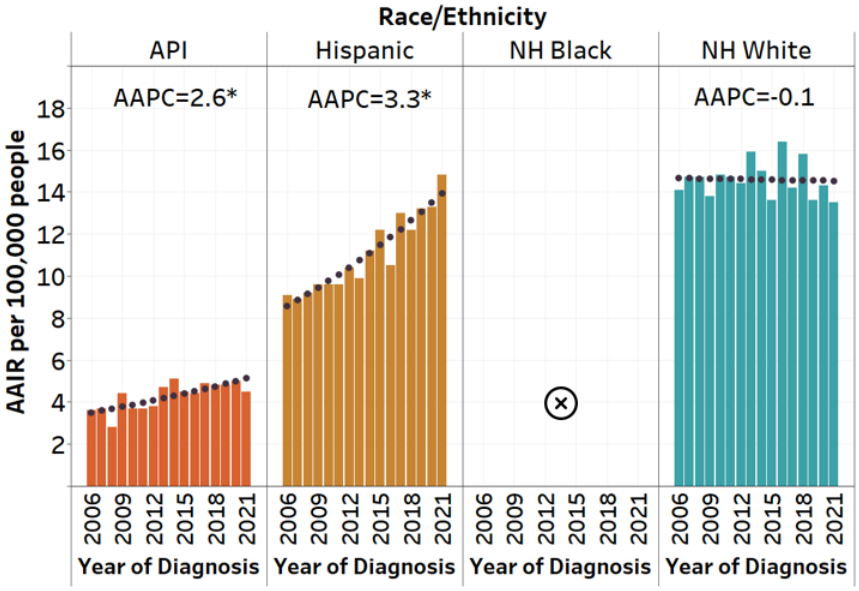


**The AAPC or APC is significantly different from zero at alpha=0.05.*

⊗Results based on annual counts less than 20 have been suppressed.

- During 2006-2018, incidence increased by 1.7 percent per year among individuals ages 20-29 years, then was stable during 2018-2021.
- During the study period, incidence increased among males 30-39 years at diagnosis by 2.0 percent per year.
- Rates were stable among males 40-49 years during the study period.

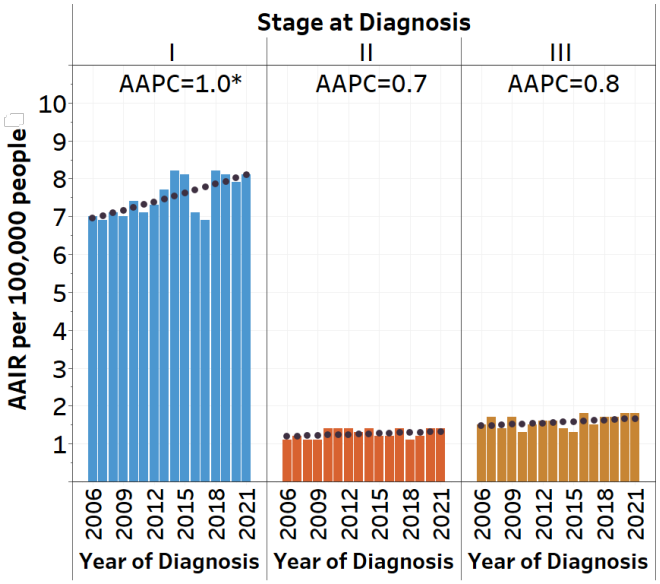
FIGURE 24. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET TESTICULAR CANCER IN CALIFORNIA BY RACE/ETHNICITY, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*
⊗Results based on annual counts less than 20 have been suppressed.

- Incidence increased among API (2.6 percent per year) and Hispanic (3.3 percent per year) males during 2006-2021.
- Incidence was stable among NH White males during the study period.

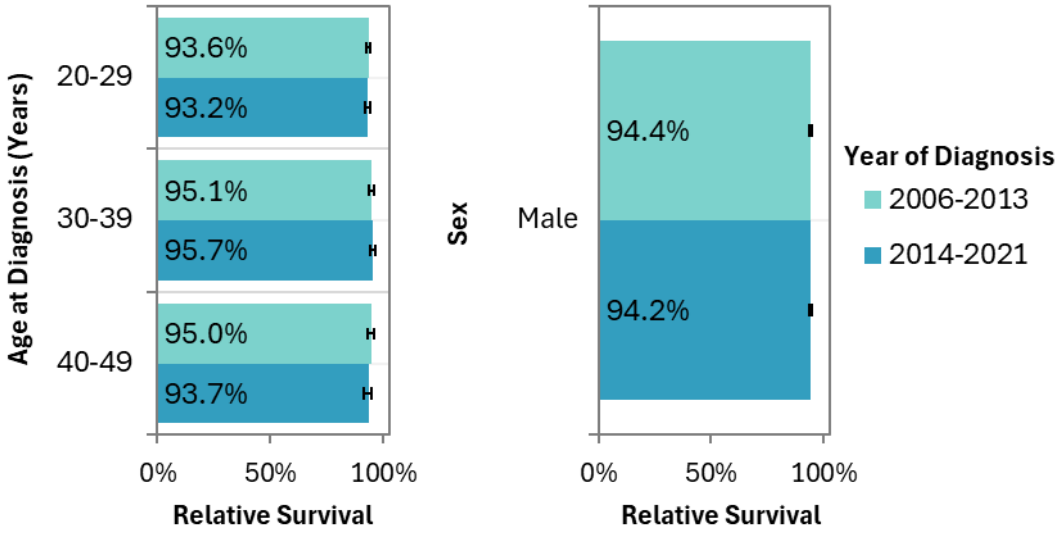
FIGURE 25. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET TESTICULAR CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

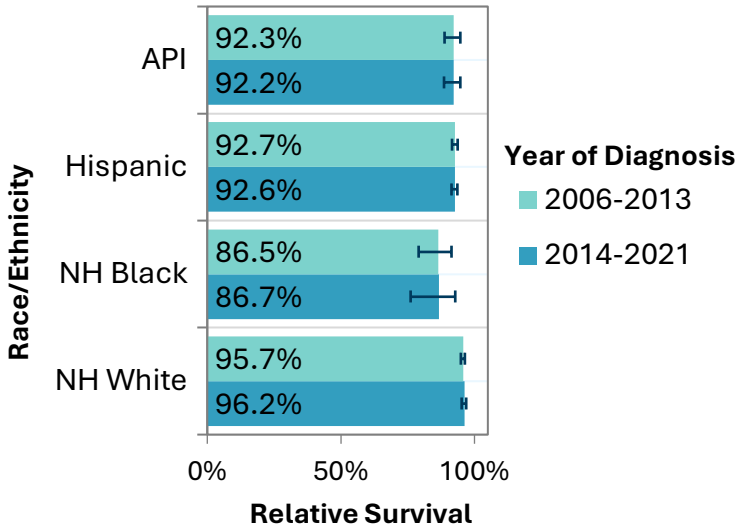
- Over the study period, incidence increased for males diagnosed at stage I (1.0 percent per year).
- The incidence of stages II and III were stable over the study period.

FIGURE 26. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET TESTICULAR CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS AND SEX 2006-2013 AND 2014-2021



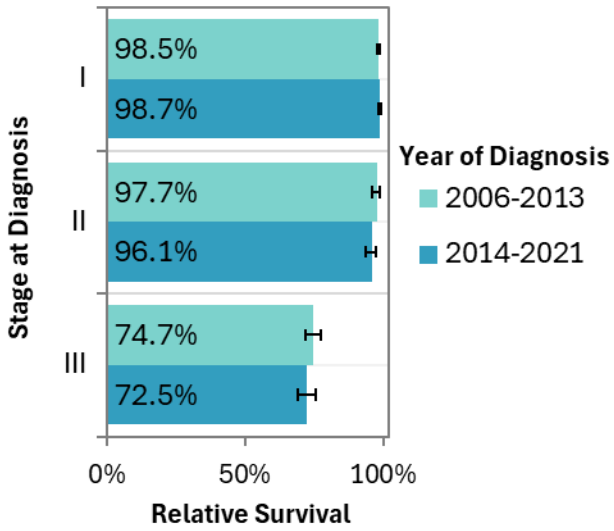
- In both study periods, males 30-39 years had the highest 5-year relative survival, followed by those aged 40-49 years and 20-29 years.
- The estimated 5-year relative survival for testicular cancer was similar in the two time periods.

FIGURE 27. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET TESTICULAR CANCER IN CALIFORNIA BY RACE/ETHNICITY 2006-2013 AND 2014-2021



- For males diagnosed from 2014-2021, the highest 5-year relative survival for early onset testicular cancer was among NH White males, followed by Hispanic, API, and NH Black males.
- The estimated 5-year relative survival for each race/ethnicity was similar in the two time periods.

FIGURE 28. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET TESTICULAR CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS 2006-2013 AND 2014-2021



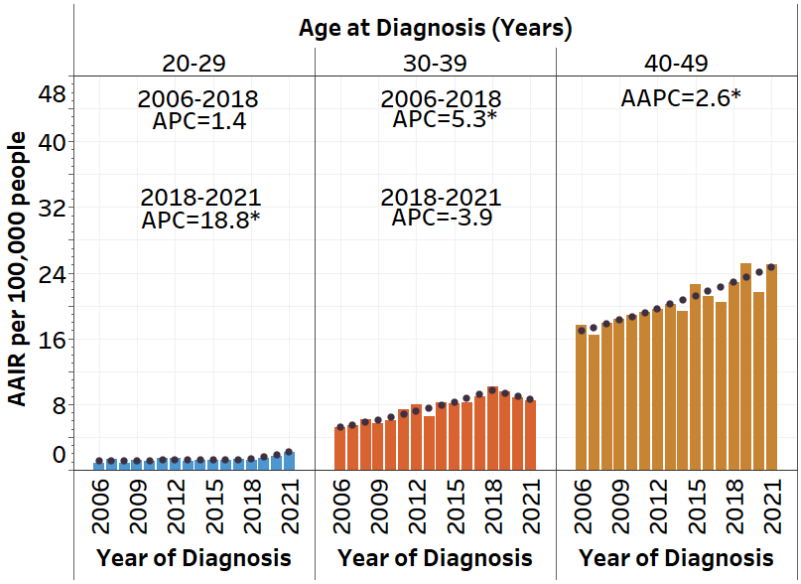
- During both study periods, males diagnosed at stage I experienced highest 5-year relative survival of early onset testicular cancer, followed by those diagnosed at stages II and III.
- The estimated 5-year relative survival for each stage was similar in the two time periods.

UTERINE CANCER

Early onset uterine cancer incidence increased by 3.0 percent per year during 2006-2021 in California. Increased incidence was observed in all age groups, among API and Hispanic race/ethnicities, and in females diagnosed at stages I, III, and IV. Females of Hispanic ethnicity experienced the largest increase in incidence over the study period (4.3 percent per year). Subgroups with the highest incidence of early onset uterine cancer in 2021 included females aged 40-49 years (25 per 100,000), of Hispanic ethnicity (14.8 per 100,000), and who were diagnosed at stage I (8.9 per 100,000). The lowest incidence in 2021 was among females aged 20-29 years (2.2 per 100,000), of NH Black race/ethnicity (4.4 per 100,000), and who were diagnosed at stage II (0.5 per 100,000).

The 5-year relative survival of early onset uterine cancer diagnosed from 2014-2021 was the lowest among females who were 20-29 years of age (86.0 percent) and NH Black (78.0 percent). Relative survival was stable from 2006-2013 to 2014-2021 among all ages, race/ethnicities, and stages at diagnosis.

FIGURE 29. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET UTERINE CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS, 2006-2021

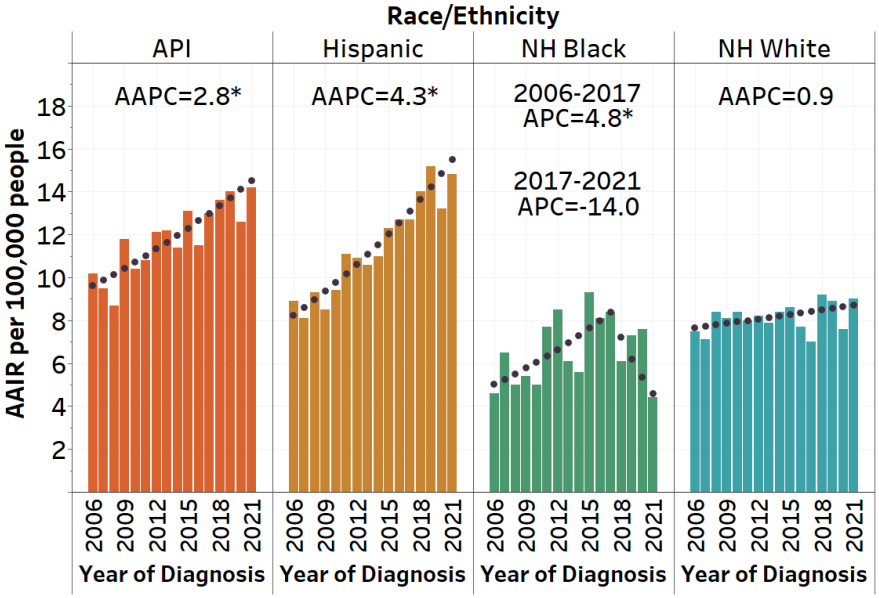


**The AAPC or APC is significantly different from zero at alpha=0.05.*

- During the study period, the incidence of early onset uterine cancer increased among all age groups. Increases were most pronounced among those aged 20-29 where incidence was stable during 2006-2018, followed by an increase of 19.0 percent per year during 2018-2021.
- Among females aged 30-39 years, incidence increased by 5.3 percent per year during 2006-2018 then remained stable during 2018-2021.

- Incidence increased by 2.6 percent per year over the study period among females 40-49 years.

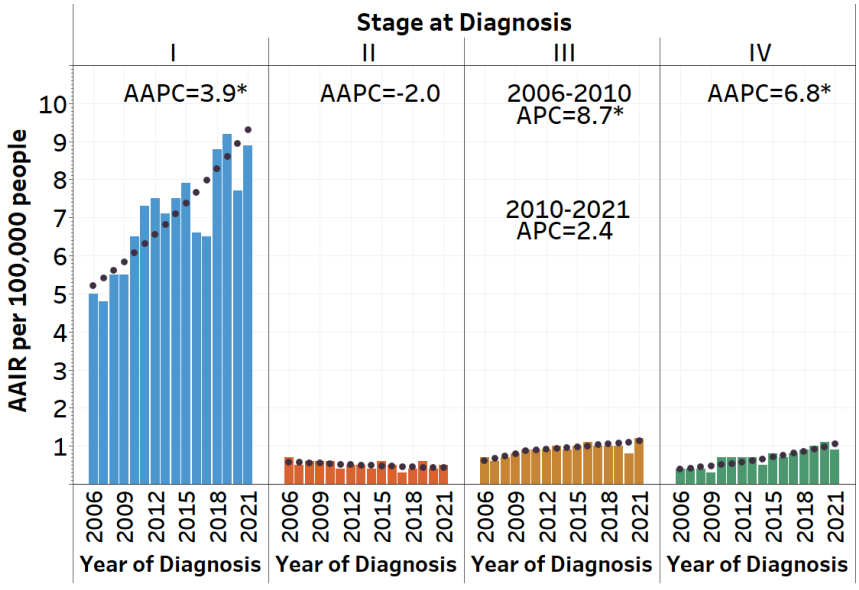
FIGURE 30. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET UTERINE CANCER IN CALIFORNIA BY RACE/ETHNICITY, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

- Incidence increased among API (2.8 percent per year) and Hispanic (4.3 percent per year) females but remained stable for NH White females during the study period.
- Incidence rose by 4.8 percent per year among NH Black patients during 2006-2017. During 2017-2021, the decreasing trend in incidence was not statistically significant.

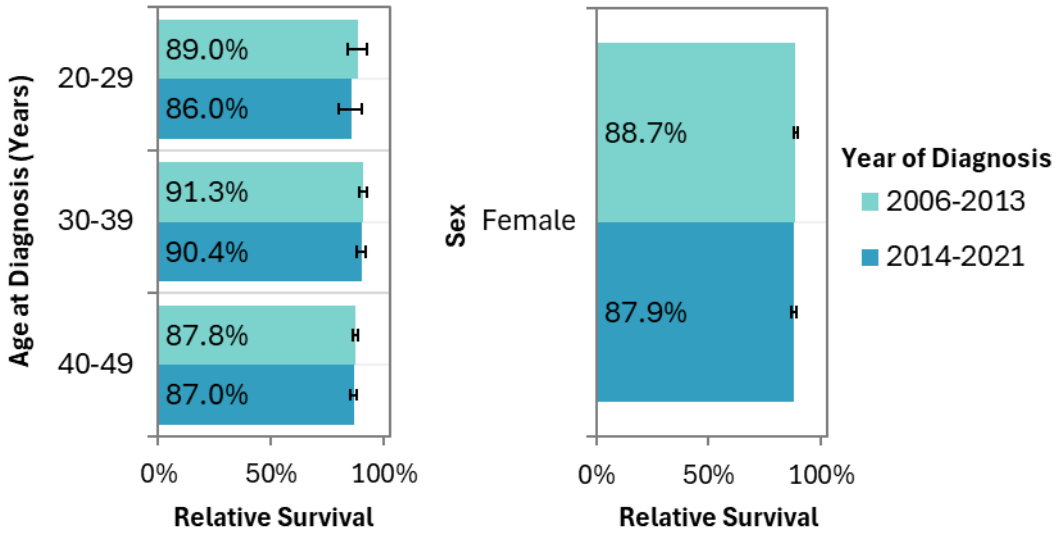
FIGURE 31. TRENDS IN AGE-ADJUSTED INCIDENCE RATES (AAIR) OF EARLY ONSET UTERINE CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS, 2006-2021



**The AAPC or APC is significantly different from zero at alpha=0.05.*

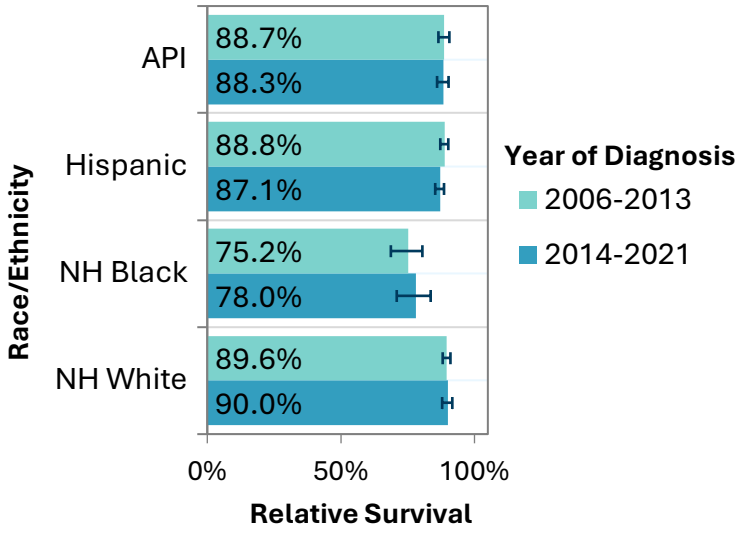
- Incidence increased during the study period for females diagnosed at stages I (3.9 percent per year) and IV (6.8 percent per year).
- Incidence was stable for females diagnosed with stage II disease during the study period.
- Among females diagnosed at stage III, incidence increased during 2006-2010 (8.7 percent per year), then was stable during 2010-2021.

FIGURE 32. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET UTERINE CANCER IN CALIFORNIA BY AGE AT DIAGNOSIS AND SEX 2006-2013 AND 2014-2021



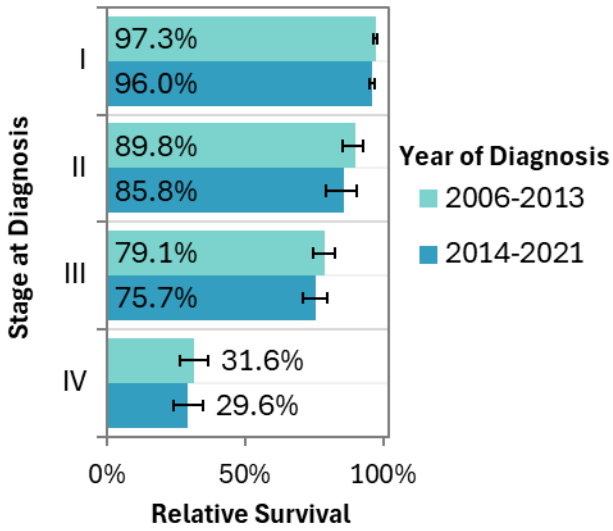
- The 5-year relative survival after early onset uterine cancer was highest among females 30-39, followed by 40-49, then 20-29 years during 2014-2021.
- The 5-year relative survival overall was similar between the two time periods.

FIGURE 33. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET UTERINE CANCER IN CALIFORNIA BY RACE/ETHNICITY 2006-2013 AND 2014-2021



- From 2014-2021, the 5-year relative survival was highest among NH White, followed by API, Hispanic, and NH Black patients.
- The relative survival for each race/ethnicity was similar in the two time periods.

FIGURE 34. 5-YEAR RELATIVE SURVIVAL OF EARLY ONSET UTERINE CANCER IN CALIFORNIA BY STAGE AT DIAGNOSIS 2006-2013 AND 2014-2021



- In both study periods, those diagnosed at stage I experienced the highest 5-year relative survival after early onset uterine cancer, followed by those diagnosed at stages II, III, and IV.
- Within each stage at diagnosis, 5-year relative survival was similar between the two time periods.

CONCLUSION

Incidence of the most common early onset cancers increased among young adults aged 20-49 years in California during 2006-2021, with disparities by age, race/ethnicity, and sex, confirming prior US-based studies[1]. The highest incidence of cancers diagnosed during the study period were female breast, thyroid, colorectal, testicular, and uterine cancers. Disturbingly, the incidence rates of each of these five cancers rose over the study period, with the highest increase in uterine (3 percent per year) and the lowest in female breast (0.7 percent per year) cancer. For all five cancer sites, the incidence among Hispanic individuals and those diagnosed at stage I disease increased. During 2006-2021, females comprised 80 percent of the cancer diagnoses, driven by female breast and thyroid cancers. We also found survival disparities by cancer type, stage at diagnosis, age at diagnosis, race/ethnicity, and sex. For patients diagnosed from 2014-2021, the lowest 5-year relative survival was experienced by racial/ethnic minorities, those diagnosed at later stages, and males. Few improvements in relative survival were observed over the study period.

Early onset breast cancer increased among females of all ages, Hispanic, NH Black and NH White race/ethnicity, and females diagnosed at all stages. A prior study found similar increasing incidence in the US among females 20-49 years and NH White and Hispanic females but observed a stable trend among NH Black females[42]. Our finding of the lowest relative survival among NH Black females compared to other racial/ethnic groups is consistent with prior findings, which attribute the disparity to later stage at diagnosis, more aggressive tumor types, and barriers to accessing healthcare[42]. Relative survival improved among those diagnosed at stage IV. Risk factors for breast cancer include obesity, sedentary lifestyle, alcohol consumption, and type II diabetes[2].

Thyroid cancer incidence was higher among female compared to male individuals, and lowest among NH Black compared to other race/ethnicities, consistent with prior studies[2,12]. Our findings of increasing stage I incidence during the beginning of the study period coincides with a period of increased imaging and incidental detection of small thyroid tumors during the early 2000s[2,4]. Although our results showed a stable trend in stage I incidence from 2010-2021, prior studies of adults in the US have shown decreasing incidence during this period following the implementation of more conservative diagnostic criteria[2]. Due to the rarity of thyroid cancers diagnosed at stages II-IV, we were unable to analyze their trends during the study period. However, other findings observing increasing incidence of larger thyroid tumors among adults less than 30 years in the US suggest that increased imaging is not the only cause of increasing early onset thyroid cancer[12]. Survival rates after thyroid cancer diagnosis remained high with no changes observed from 2006-2013 to 2014-2021, consistent with prior studies[4]. Risk factors for thyroid cancer include obesity, history of irregular menstrual cycle, Hashimoto thyroiditis, history of goiter, and exposure to radiation[2,45].

Our finding of increased incidence of early onset colorectal cancer is supported by prior studies[1,11,46-48]. Incidence has increased in the US since the 1990s due to rising obesity rates, sedentary lifestyle, and diets high in processed and red meats and low in whole grains, fruits, and vegetables[2]. Consistent with prior studies, we found disparities in incidence rates and trends by race/ethnicity, sex, and age; including increasing

incidence among individuals of 30-49 years, Hispanic and NH White race/ethnicity, and those diagnosed at stages I, III, and IV, with the highest rates among NH Black and male individuals[6]. Relative survival increased over the study period for individuals diagnosed at stages III and IV. Similar findings in previous studies attributed this trend to advances in surgical methods and treatment of metastases to the liver[48]. However, disparities in relative survival were observed by race/ethnicity, with the lowest rate among NH Black individuals, suggesting that not all subgroups are benefiting equally from these treatment advances[48].

We found increasing incidence of testicular cancer, in line with prior studies[49]. The average age of testicular cancer diagnosis for males in the US is 33, consistent with our finding of the highest incidence among males aged 30-39[49]. Although some prior studies observed the highest incidence rates among NH White males, we found the highest incidence rate in 2021 to be among Hispanic, followed by NH White, males[49]. Increasing incidence was observed among Hispanic and API males, consistent with prior studies[50]. The lowest 5-year relative survival rate from 2014-2021 was among NH Blacks, supporting prior findings that the highest early onset testicular cancer mortality is among NH Black individuals compared to other racial/ethnic groups[51]. Risk factors for testicular cancers are not well understood. However, some studies have found associations of testicular cancer with cryptorchidism, low birth weight, and cannabis use[52].

Early onset uterine cancer increased by three percent per year over the study period. Although prior research of adults in the US shows a one percent increase per year among NH White females and two to three percent increase per year among other racial/ethnic groups, we observed a stable trend among NH White females with increasing incidence among API, Hispanic, and NH Black females[2]. Our finding of increasing incidence among females 20-49 years was consistent with prior work[53]. Additionally, both the highest incidence, and the greatest increase in incidence over the study period, was among females 40-49 years, as observed in prior studies[53]. Consistent with other studies, we found the lowest relative survival after uterine cancer to be among NH Black patients[53]. Some studies of adults in the US have found that Black females have a mortality rate 80 percent higher than NH White females for endometrial cancer, the most common type of uterine cancer, due to more aggressive tumor types, higher stage at diagnosis, worse access to treatment, and use of less aggressive treatments[54,55]. Up to 60 percent of uterine cancers may be attributed to obesity, the prevalence of which is highest in Hispanic individuals in the US[2,56]. Other risk factors include sedentary lifestyle and type II diabetes[2].

Cancer is associated with significant morbidity[57]. For example, with longer survival times following cancer diagnosis, young adults face several adverse health outcomes, such as the development of chemotherapy-induced peripheral neuropathy, which can cause pain, numbness, and loss of sensation in a patient's hands and feet[58]. Chemotherapy may also result in the later development of cancers, such as myelodysplastic syndromes, leukemia, lymphoma, or late effects, such as cardiovascular disease, which impacts survival[4,59,60]. Additionally, fertility preservation is a concern for many young adults with cancer. Treatments may limit endocrine function or cause infertility among survivors[61]. Preventive measures to lower the risk of early onset cancers include uptake of the HPV vaccine for individuals under age 27, adhering

to cancer screening guidelines and following up after abnormal results, quitting/not using tobacco, exercising regularly, maintaining a healthy weight, consuming a healthy diet high in fiber and low in red meat, limiting alcohol consumption, and limiting exposure to carcinogenic compounds, such as tobacco smoke and pesticides[5,62-65]. However, some risk factors for early onset cancer are non-modifiable, such as genetic predisposition[8].

Our report has limitations. Because of the rarity of cancer in some subgroups, trends in incidence could not be calculated. We were also unable to examine incidence or relative survival by known cancer risk factors, such as carcinogen exposure, obesity, tobacco and alcohol use, and genetic predisposition[1,5,8,15,62,65]. Despite these limitations, our report demonstrates the need for improved early onset cancer prevention and screening, especially among disadvantaged subgroups of young adults in California. Young adult cancer patients face a unique set of adversities as they are historically the least insured age group in the United States and may have limited financial resources, leading to delayed or foregone cancer treatment[2,16,17,19]. Additionally, they are less likely to attend primary care visits or adhere to screening recommendations than other age groups, leading to potentially later stage cancer diagnosis and increased morbidity and mortality[2,20,21,25,26].

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