INTERIM FINDINGS REPORT,

KEY DRIVERS OF CANCER IN IOWA PROJECT

FEBRUARY 2026

Provided by the University of Iowa College of Public Health

Interim Findings Report, Key Drivers of Cancer in Iowa Project, supported by the Iowa Legislative Assembly, February 2026

Executive Summary, Key Drivers of Cancer in Iowa

University of Iowa College of Public Health

For the 5-year reporting period 2018-2022, Iowa had the second highest rate of new cancers (also referred to as cancer incidence) in the US and was one of only two states with a rising rate of new cancers. To better understand what drives Iowa's high cancer rates, the **Key Drivers of Cancer in Iowa** project was launched following the Governor's recommendation and the Iowa General Assembly's authorization of a $1 million appropriation to the University of Iowa (UI). With this support, the UI College of Public Health assembled a team of cancer and data experts to collaborate with the Iowa Department of Health and Human Services to identify key contributors and inform effective statewide interventions. The project began in July 2025 and runs through June 30, 2026. This interim report shares the preliminary results of this work to date.

Data sources included the Iowa Cancer Registry, CDC Wonder, the North American Association of Central Cancer Registries (NAACCR) Cancer in North America File (CiNA), the American Community Survey, and the Behavioral Risk Factor Surveillance System (Iowa and US).

How many more cases of cancer are diagnosed among Iowans compared to the rest of the US?
Excess cases are calculated as the estimated number of additional cancers diagnosed among Iowans compared to the number of cases that would have been diagnosed if Iowa had the same age- and sex-specific cancer rates as the US. An estimated 2,582 more Iowans (ages 20+) were diagnosed with cancer in 2022 compared to the number of cancer cases that would have been expected if Iowa experienced the same age-sex-specific rate of cancer as the US. This includes 331 more Iowans diagnosed with prostate cancer, 141 more with breast cancer, 376 more with lung cancer, 189 more with colorectal cancer, 400 more with skin melanoma, and 1,145 more Iowans diagnosed with other types of cancer combined.

How do Iowa's cancer incidence and mortality rates by stage at diagnosis compare to the rest of the US?
Iowa's high rates of prostate cancer, breast cancer, colorectal cancer, and melanoma are largely driven by higher rates of early stage (localized cancers), which helps explain why Iowa's mortality rate for these cancers is similar to the overall US mortality rate despite Iowa's higher incidence rates. Conversely, Iowa's high rate of lung cancer is largely driven by a higher rate of distant (metastatic cancer), which contributes to Iowa having a higher lung cancer mortality rate than the rest of the US.

Do residents in other states have similar demographic characteristics and behavioral risk factors as those in Iowa? If so, do they have similarly high rates of new cancers?
Based on available data, states shown in the same color in **Figure 1** share similar demographic characteristics and self-reported behavioral risk factors. Iowans share similar characteristics (above average health insurance, average income and education, and a small proportion of Black people in the population) and self-reported behaviors (high binge drinking, above average obesity and percent of people not consuming any vegetables, and average smoking) as many of our adjacent states highlighted in teal (Nebraska, North Dakota, South Dakota, Minnesota and Wisconsin).

Figure 1. State clusters based on demographic characteristics and self-reported behavioral risk factors, 2022.

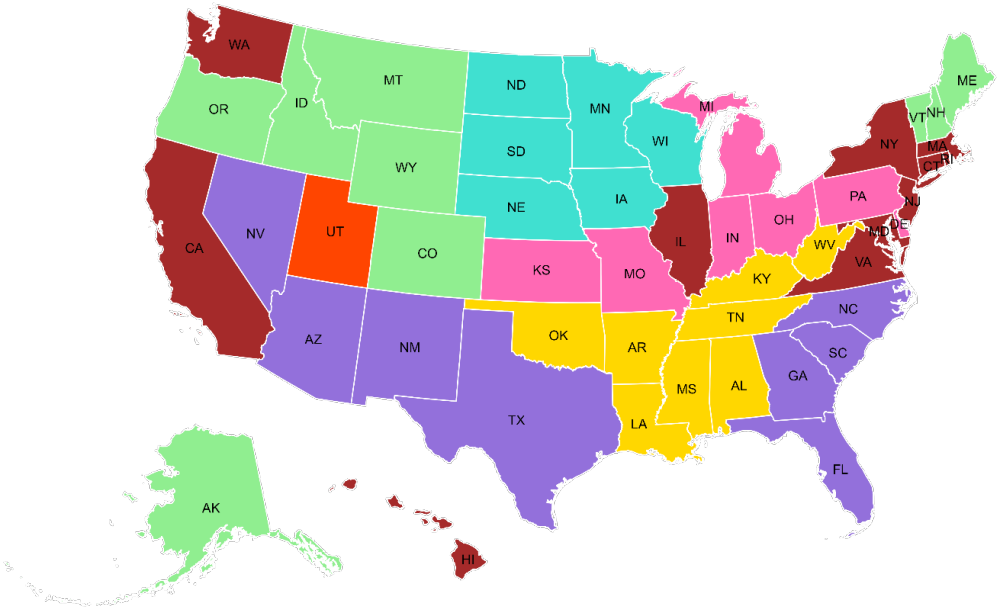
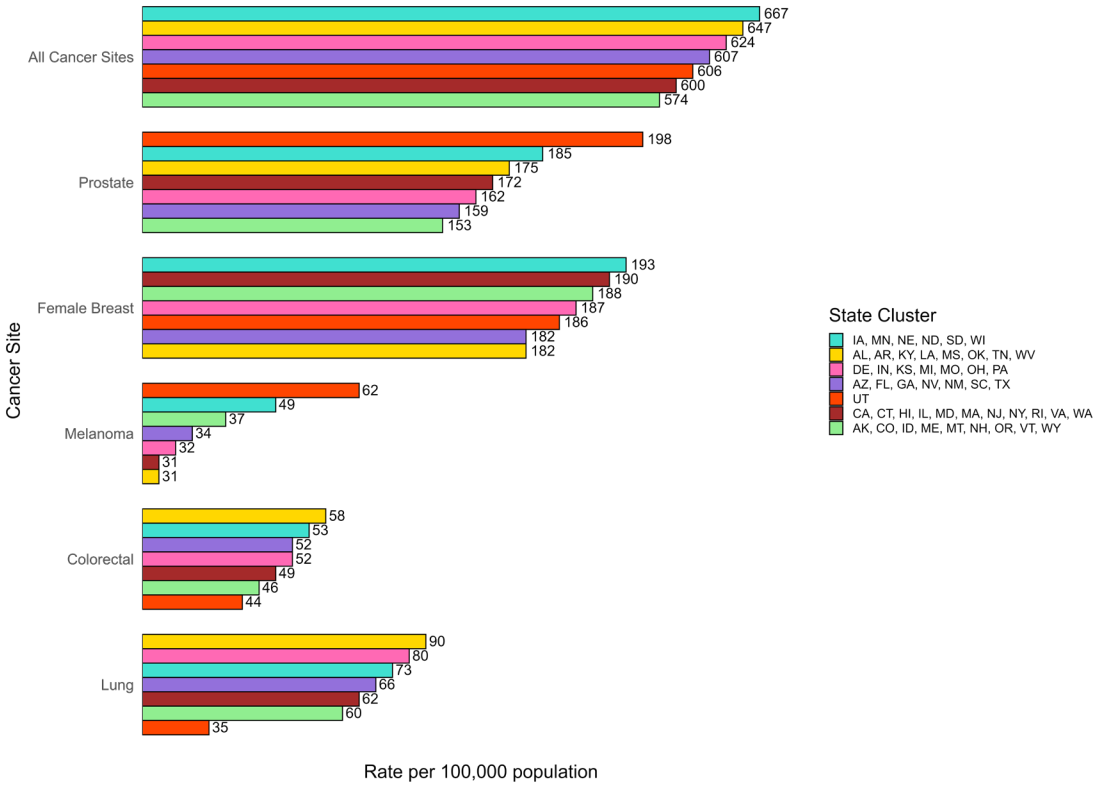


Figure 2. Age adjusted cancer rates (ages 20+ years) by state cluster, 2022.



As shown in **Figure 2**, the state cluster that includes Iowa (henceforth, Iowa cluster) had a higher age-adjusted incidence rate of cancer in 2022 than all other state clusters in the US. The Iowa cluster also had the highest age-adjusted incidence rate of female breast cancer, the second highest rates for prostate cancer and melanoma (below the orange cluster represented solely by Utah which has one of the lowest overall cancer rates in the US and is the only other state besides Iowa with a rising incidence rate), the second highest age-adjusted rate of colorectal cancer (below the yellow cluster), and the third highest age-adjusted rate of lung cancer (below the yellow and pink clusters).

How do trends in incidence and mortality among Iowans compare to states with similar demographic characteristics and self-reported behavioral risk factors?
Within the Iowa cluster in 2022, Iowa had the highest overall cancer rate, the highest age-adjusted rates of lung cancer and colorectal cancer, the second highest age-adjusted rate of breast cancer, and the third highest age-adjusted rates of prostate cancer and melanoma. Iowa has a higher overall age-adjusted rate of early stage (localized) incidence compared to the other states in the Iowa cluster but also has a higher age-adjusted rate of distant (metastatic) lung cancer. Iowa's age-adjusted mortality rates are generally similar to other states in the same cluster except for lung cancer, which is substantially higher in Iowa.

How many more cases of cancer are diagnosed among Iowans compared to states with similar risk factors/demographics?
An estimated 1,298 more Iowans (ages 20+) were diagnosed with cancer in 2022 compared to the number of cancer cases that would have been expected if Iowa experienced the same age-sex-specific rate of cancer as the Iowa cluster. This includes 66 more Iowans diagnosed with prostate cancer, 64 more with breast cancer, 329 more with lung cancer, 206 more with colorectal cancer, 26 more with melanoma, and 607 more diagnosed with other types of cancer combined.

What are the key takeaways from the analysis of state clusters?
Residents in states that cluster with Iowa (Minnesota, Wisconsin, Nebraska, North Dakota, and South Dakota) have similar demographic characteristics and self-reported cancer-related behavioral risk behaviors, and the cluster has the highest cancer rate of all clusters and the US as a whole. Compared to states within the Iowa cluster, Iowa has among the highest rates of most common cancers, which leads to 1,298 excess cases of cancer. Also compared to other states in the Iowa cluster, Iowans have one of the highest percentage of people who are insured. This contributes to good access to healthcare among Iowans, which can lead to more diagnoses of early-stage cancers; it can also lead to more diagnoses of cancers that may have otherwise never been detected (e.g., prostate cancer). Within the Iowa cluster, Iowans rank among the highest in binge drinking, obesity, and people consuming few vegetables, which increases the risk of many types of cancers, including breast cancer. Compared to states in the Iowa cluster, Iowa stands out most for lung cancer, particularly higher age-adjusted incidence, late-stage incidence, and mortality.

Which Iowa counties have the highest numbers of excess cases of cancer (irrespective of their demographic characteristics and behavioral risk factors)?
In 2018-2022, 87 of Iowa's 99 counties had a significantly higher number of excess cases of overall cancer above what would be expected if each county had the same age-sex-specific rate as the US. For prostate cancer, 18 counties in west/northwest Iowa and 16 counties in east/northeast Iowa had a significantly higher number of excess cases of prostate cancer than would be expected. No Iowa counties had a significantly higher number of excess cases of premenopausal breast cancer, but 11 counties across Iowa had a significantly higher number of

postmenopausal breast cancer, with 6 of the counties clustered together in central Iowa. While this approach highlighted which counties in Iowa have the highest numbers of excess cases of cancer, it did not take into account the demographic characteristics and behavioral risk factors of each county. As the state cluster analysis illustrated, these characteristics and factors have a large impact on cancer rates. We therefore constructed models to estimate what the cancer rates in Iowa, and in Iowa's individual counties, would look like after accounting for these characteristics and factors.

What proportion of Iowa's incidence rates can be explained by demographic characteristics and behavioral risk factors? And after taking these characteristics and factors into account, what should Iowa's cancer rates be?

Models accounting for demographic characteristics and behavioral risk factors suggest that Iowa's cancer rates should be somewhat higher than those in the US overall (based on these known risk factors and demographic characteristics in Iowa). However, Iowa's rates for most cancers are still a bit higher than what the models predict, as shown in **Table 1** below.

Table 1. Comparison of cancer rates between the US vs. the observed rate in Iowa vs. the rate that was predicted for Iowa based on demographic characteristics and behavioral risk factors.

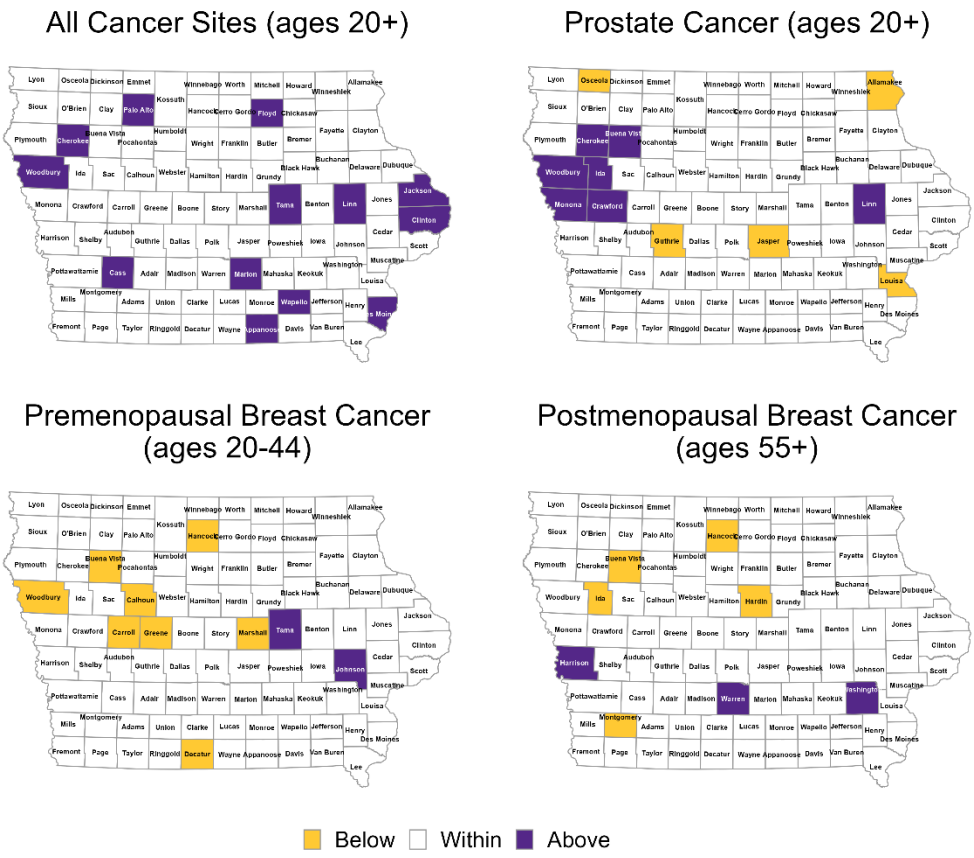
	Per 100,000 Population			
	U.S. Rate	**Observed Iowa Rate**	**Model Predicted Rate for Iowa**	**Variables Included in Model** (Percent of Population with the Characteristic/Risk Factor)
All Cancers Combined	622	692	671	% Obese, % White population, % Binge drinking, % Checkup in past year
Prostate Cancer	163	182	180	% Married, % Insured % Black population, % Obese, % Binge drinking, % Never smoked, % Up-to-date with PSA screening
Pre-menopausal Breast Cancer	53	55	55	% Insured, % White population, % Binge drinking, % Never smoked, % Up-to-date with mammogram
Post-menopausal Breast Cancer	386	407	395	% With Bachelor's degree, % White population, % Obese, % Binge drinking, % Up-to-date with mammogram

These findings suggest that while demographic characteristics and behavioral risk factors explain a large proportion of Iowa's high cancer incidence rate, there are still other factors contributing to the higher rates of these cancers observed in Iowa.

Which counties have the highest incidence of cancer (after accounting for demographic characteristics and behavioral risk factors)?

By applying the same models (with the same variables as listed in **Table 1**) to the counties in Iowa, we determined which counties had higher or lower than expected rates of cancer after accounting for demographic characteristics and behavioral risk factors.

Figure 3. Counties with cancer incidence rates (2018-2022) that were: higher than expected (shaded purple), within the expected range (shaded white), or lower than expected (shaded yellow) after accounting for demographic characteristics and behavioral risk factors (2013-2017).



For all cancers combined (ages 20+ years), 13 of Iowa's 99 counties had a cancer incidence rate that was significantly higher than expected, and no counties had a significantly lower than expected rate.

For prostate cancer (ages 20+ years), six northwestern Iowa counties plus Linn County had a significantly higher than expected rate, and 5 counties had a significantly lower than expected rate.

For premenopausal breast cancer (ages 20-44 years), two Iowa counties (Tama and Johnson) had a significantly higher than expected rate, and eight counties had a lower than expected rate.

For postmenopausal breast cancer (ages 55+ years), three counties (Harrison, Warren and Washington) had a significantly higher than expected rate, and five counties had a lower than expected rate.

The higher than expected rates in the identified counties cannot sufficiently be explained by the demographic characteristics and behavioral risk factors that were available for analysis and included in the models. These counties represent the biggest opportunities to explore other types of risk factors (genetic, environmental, provider screening patterns, etc.).

Next Steps

The work on this project will continue through June 2026. Four additional cancers will be examined including lung, melanoma, colorectal, and HPV-associated cancers. At that time, a full report will be prepared with results and recommendations.

Interim Findings Brief Summary, Key Drivers of Cancer in Iowa Project

- An estimated 2,582 more Iowans (ages 20+) were diagnosed with cancer in 2022 compared to the number of cancer cases that would have been expected if Iowa experienced the same age-sex-specific rate of cancer as the US. This includes:
    - 331 more prostate cancer cases
    - 141 more breast cancer cases
    - 376 more lung cancer cases
    - 189 more colorectal cancer cases
    - 400 more skin melanoma cancer cases
    - 1,145 more cases of other types of cancer
- Iowa's incidence rates are largely driven by early stage (localized) cancers except for lung cancer. Iowa's mortality rates are similar to those in the US as a whole, again except for lung cancer.
- Iowa shares similar behavioral risk factors and demographics (referred to as clustering) with the following adjacent states: Nebraska, Minnesota, North Dakota, South Dakota, and Wisconsin.
- Iowa's cluster of states had the highest, or among the highest, rates of all cancers combined, and each of the five most common cancers (prostate, breast, melanoma, lung, and colorectal).
    - Iowa has one of the highest percentages of insured individuals compared to the other states in the cluster, which suggests good healthcare access.
- In this report, rates of prostate cancer, pre- and postmenopausal female breast cancer, and all cancers combined were each modeled to evaluate the relationship between those cancer rates and available behavioral and demographic risk factors. For these cancer types, several counties in Iowa continued to have higher rates of cancer than expected after accounting for the available behavioral risk factors and demographic variables. These same models will be evaluated for lung, melanoma, colorectal, and HPV-associated cancers in future reports.
    - Variables examined include: % obesity, % binge drinking, % never smoked, % checkup in past year, % PSA screening (for prostate cancer), % up to date mammogram (for breast cancer), % insured, % educated, and % White or % Black.
- Counties that were identified as having higher than expected cancer rates after accounting for the effect of behavioral risk factors and demographics represent the biggest opportunities for further analysis on additional risk factors such as genetic or environmental.

Lung, melanoma, colorectal, and HPV-associated cancers are the next cancer sites to be analyzed using the same methods detailed in this summary.

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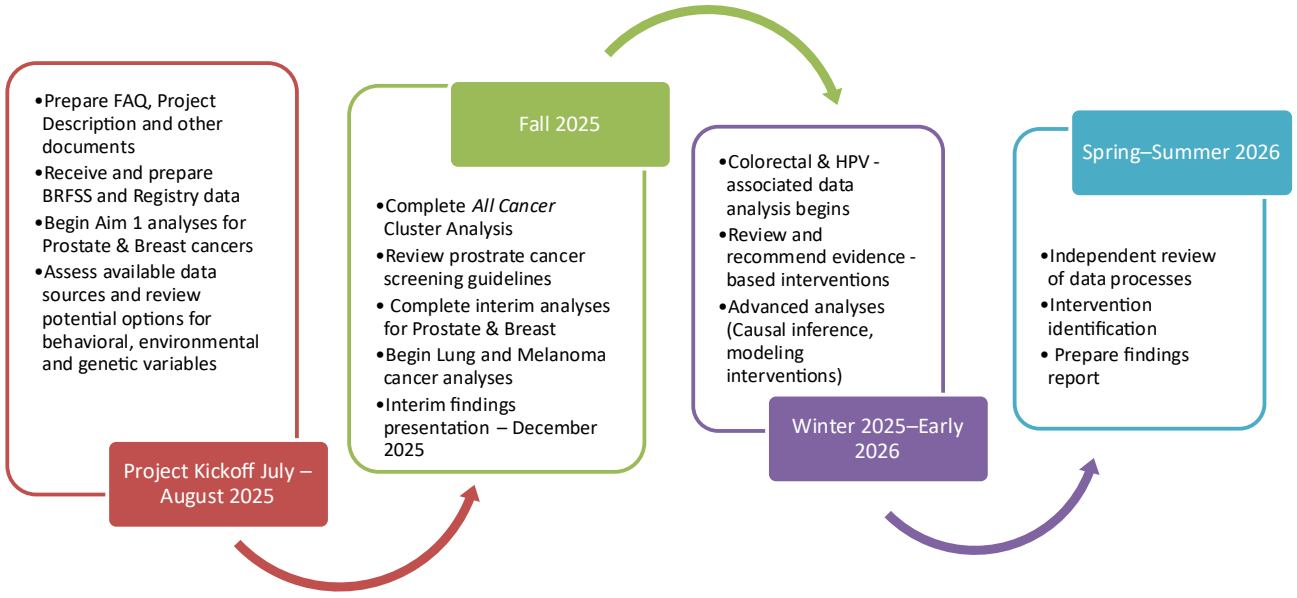
Background and Introduction

For the 5-year reporting period 2018–2022, Iowa had the second highest rate of new cancers (also referred to as cancer incidence) in the U.S. and was one of only two states with a rising rate of new cancers. To better understand what drives Iowa's high cancer incidence rates, the **Key Drivers of Cancer in Iowa** project was launched following Governor Reynold's recommendation and the Iowa General Assembly's authorization of a $1 million appropriation to the University of Iowa. With this support, the UI College of Public Health assembled a team of cancer and data experts to collaborate with the Iowa Department of Health and Human Services, to identify key contributors and inform effective statewide interventions.

The project began in July 2025 and runs through June 30, 2026. A series of research activities and data analysis will take place over 12-months as depicted in the high-level timeline below. The funding supports the time of Epidemiologists, Biostatisticians, research staff and students to complete the work. Funds spent through the initial five months of the project total $431,800.

Key Drivers of Cancer in Iowa Project Timeline (July 2025 – June 2026)



The project began July 1, 2025, and will continue for one year (through June 2026), during which time the team is pursuing several key research directions. Using Surveillance,

Epidemiology and End Results (SEER) cancer registry data and specialized statistical techniques, researchers are in the process of mapping cancer incidence rates across Iowa, drilling down to the county level. The analysis focuses on six cancers—prostate, female breast, lung, melanoma, colorectal, and HPV-associated cancers. The team is evaluating whether known behavioral risk factors, such as using tobacco products or consuming alcoholic beverages, explain why some communities experience significantly higher or lower rates of cancer than the national average. Researchers are also examining variation in prostate cancer screening practices across the state to determine whether level of adherence to screening guidelines contributes to Iowa's elevated cancer incidence rates.

The team will also review successful prevention and detection programs from other states with similar risk profiles, with the goal of adapting effective strategies for Iowa. In addition, groundwork will begin on compiling genetic and environmental data for a more detailed analysis planned for the project's second year. The full project, Aims 1- 5 is a two-year project. Aims 1, 2 and part of Aim 3 will be completed by June 30, 2026. The remaining Aims will be completed in the second year of the project (July 2026 – June 2027), with funding support from the Rural Transformation grant.

Specific project aims are listed in Table 1. Aims 2–5 build on the work of Aim 1.

Table 1. Key Drivers of Cancer in Iowa Project Aims

Project Aim 1 Using SEER Registry data and advanced analytic techniques, map current cancer incidence rates to the county level (or smaller geographic units when possible) for the six specific cancer sites in the state of Iowa while adjusting for known behavioral risk factors. 1a. Identify the geographic units (counties) that have more cases than would be expected if Iowa followed national trends in cancer incidence rates. Assess whether known modifiable risk factors explain the number of excess cases. 1b. Identify the geographic units (counties) that have fewer cases than would be expected if Iowa followed national trends in cancer incidence rates. Assess whether known modifiable risk factors explain the fewer number of cases. 1c. Conduct an association analysis between cancer incidence rates and behavioral risk factors followed by a causal inference analysis for each specific cancer.
Project Aim 2 Investigate the possible role of provider screening behavior in the increased incidence rate of prostate cancer in Iowa. 2a. Conduct a separate assessment that examines provider behavior around screening recommendations for prostate cancer.

Project Aim 3
Identify and model successful population level health interventions.

3a. Undertake a review to identify successful population health interventions, including policies and legislation, that have been adopted by other states and have been found to move the needle on these cancers and their risks.

3b. Compile detailed resource lists of these interventions and conduct a SWOT analysis to identify how appropriate the interventions are for Iowa.

3c. Model the identified successful and suitable interventions to calculate potential impact on cancer mortality, years of productive life lost, and cost-benefit of the intervention.

Project Aim 4
Examine potential environmental, diagnostic, and genetic risk factors.

4a. For the environmental risk factors where data are able to be obtained, initiate association and causal inference statistical modeling.

4b. Use Iowa Cancer Registry data to build on spatiotemporal analyses of selected incident cancers hypothesizing that hormonal-mediated cancers will demonstrate geographic clustering in regions.

Project Aim 5
Work with Iowa HHS on implementation and evaluation of identified population level interventions and evaluation of population interventions focused on these six specific cancers.

This in-depth analysis will help us understand which cancers are driving Iowa's incidence rates, which areas of the state are higher than the national average in cancer incidence by cancer site, and which interventions might work best in targeted geographic areas of Iowa.

The report is organized by aim. Each aim will provide information about the work completed as well as challenges/barriers and next steps. Each section details the work to date, including data preparation, validation, methodological decisions, and preliminary analytical results.

This interim report provides information gleaned from the work done since the project began July 1, 2025. **The research described in this report is part of a large ongoing collaborative effort and continues to be refined throughout the course of the study and therefore is subject to change.**

The full project, Aims 1- 5 will take two years to complete. Aims 1, 2 and part of Aim 3 will be completed by June 30, 2026. The remaining Aims will be completed in the second year

of the project (July 2026 – June 2027), with funding support from the Rural Transformation grant.

Project Aim 1

Using SEER Registry data and advanced analytic techniques, map current cancer incidence rates to the county level (or smaller geographic units when possible) for the six specific cancer sites in the state of Iowa while adjusting for known behavioral risk factors.

Initial analysis began with two cancers, prostate and female breast cancer, to establish the analytical model which was developed for this investigation. This analysis will be applied to the other four cancers of interest—lung, melanoma, colorectal, and HPV-associated cancers—which will be discussed in the final report due July 2026. Each cancer type requires a slightly different approach based on known demographic and behavioral risk factors, but the general methods for the investigation will remain the same. Final results may also include different year and age groupings as research continues.

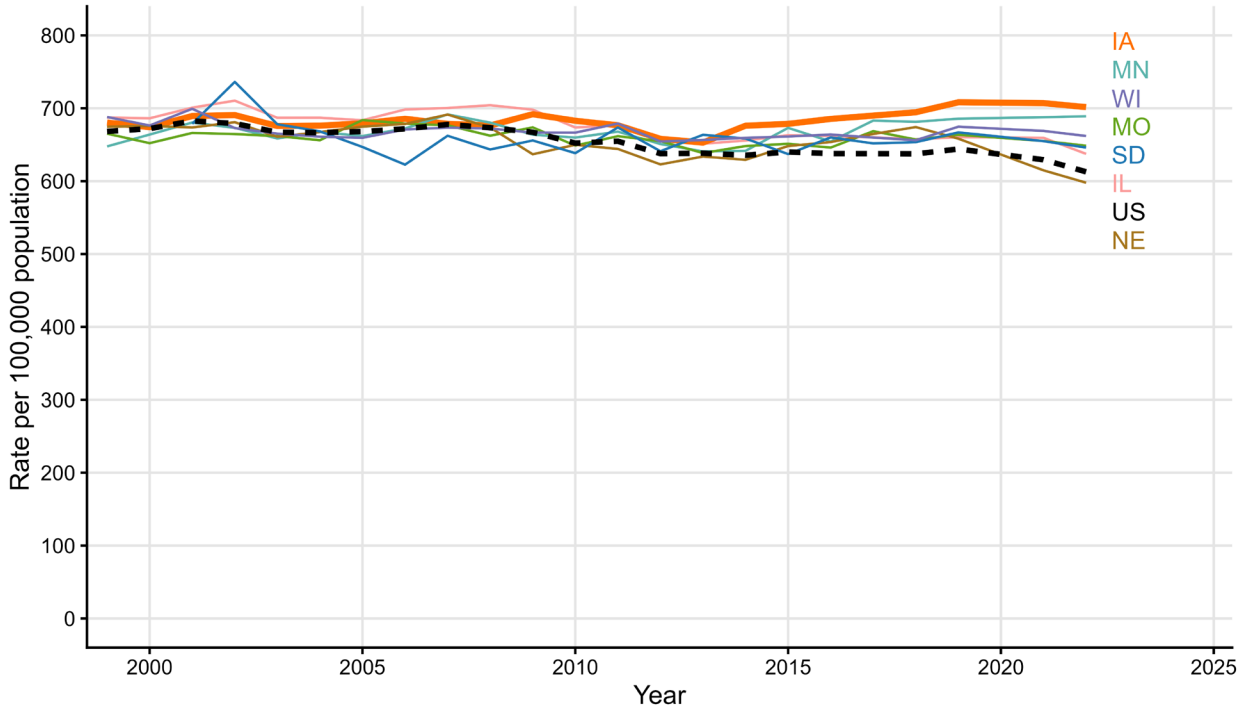
For each cancer site, the approach, method, and rationale are described, followed by results.

Overview of Iowa's Cancer Rates

The Iowa Cancer Registry's 2025 Cancer in Iowa report stated that Iowa continues to have the second highest age-adjusted cancer incidence rate over the most recent 5-year reporting period. The age-adjusted cancer incidence rate across the United States (U.S.) for 2022, the most recent year of available data, was 612.8 new cases of cancer per 100,000 people (males and females, ages 20+ years), while Iowa's age-adjusted cancer incidence rate in 2022 was 701.6 new cases of cancer per 100,000 people (males and females, ages 20+ years and older).

Cancer incidence rates for Iowa's neighboring states were also elevated compared to the U.S. over the last 5–10 years of data, though their incidence rates have been lower than Iowa (**Figure 1**). These patterns of how Iowa compares to the U.S. average and how Iowa compares to its neighboring states provide the context for the more detailed analyses presented in this report.

Figure 1. **All Cancer Sites, Ages 20+**: Age-adjusted incidence rates for the U.S., Iowa and bordering states



Data Source: CDC WONDER

Figure 1 presents age-adjusted incidence rates for all cancer sites combined and can be used to compare Iowa and its neighboring states with the U.S. national rate from 1999 through 2022. From 1999 through 2013, Iowa's rates closely follow the U.S. rate. After 2013 however, the national trend shows a decline in incidence, in contrast to an increasing trend observed in Iowa and most of the surrounding states.

These incidence rates reflect all cancer sites combined and may be driven by increases in specific leading cancer types. To explore this further, **Table 2** summarizes the 10 cancer types with the highest age-adjusted incidence rates among adults ages 20+ in Iowa compared to the U.S. from 2018–2022. Iowa's age-adjusted incidence rate is higher than the U.S rate for each of the 10 cancers. Iowa ranks in the top 10 states for eight of the 10 cancers.

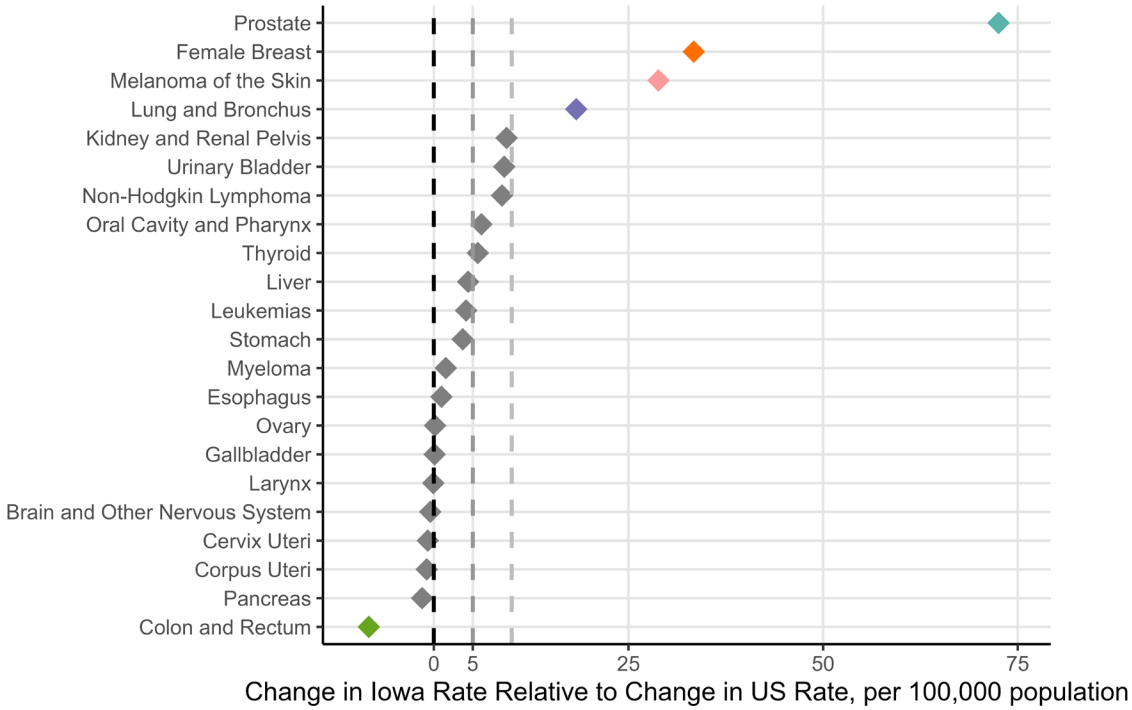
Table 2. Age-adjusted incidence rates of **top 10 cancers** in Iowa compared to the U.S., ages 20+, diagnosis years 2018–2022

Leading Cancer Site	Iowa's Rank (out of 50)	Iowa Age-Adjusted Rate per 100,000	U.S. Age-Adjusted Rate per 100,000
Female Breast	13th	192.3	□□.□
Prostate	12th	181.6	□□.□
Lung and Bronchus	10th	84.0	□□.□
Colon and Rectum	8th	56.2	□□.□
Melanoma of the Skin	2nd	45.8	□□.□
Uterus	6th	42.2	□□.□
Bladder	7th	30.5	□□.□
Non-Hodgkin Lymphoma	1st	29.8	□□.□
Kidney and Renal Pelvis	7th	29.4	□□.□
Leukemia	1st	22.4	□□.□

Data Source: CDC WONDER

Figure 2 shows a comparison of changes in age-adjusted cancer incidence rates in Iowa relative to corresponding changes at the national level. In **Figure 1**, Iowa's rates began consistently increasing above the U.S. and other states in 2013, so **Figure 2** displays changes between Iowa and the U.S. for the 2013–2022 time period. Prostate cancer shows the largest divergence between Iowa and U.S. trends, followed by female breast, melanoma of the skin, and lung and bronchus. This means that these cancers are increasing at a greater rate in Iowa compared to the rest of the U.S. These observed differences provide additional context for the cancers examined in this project, highlighting areas where Iowa's trends depart from national patterns.

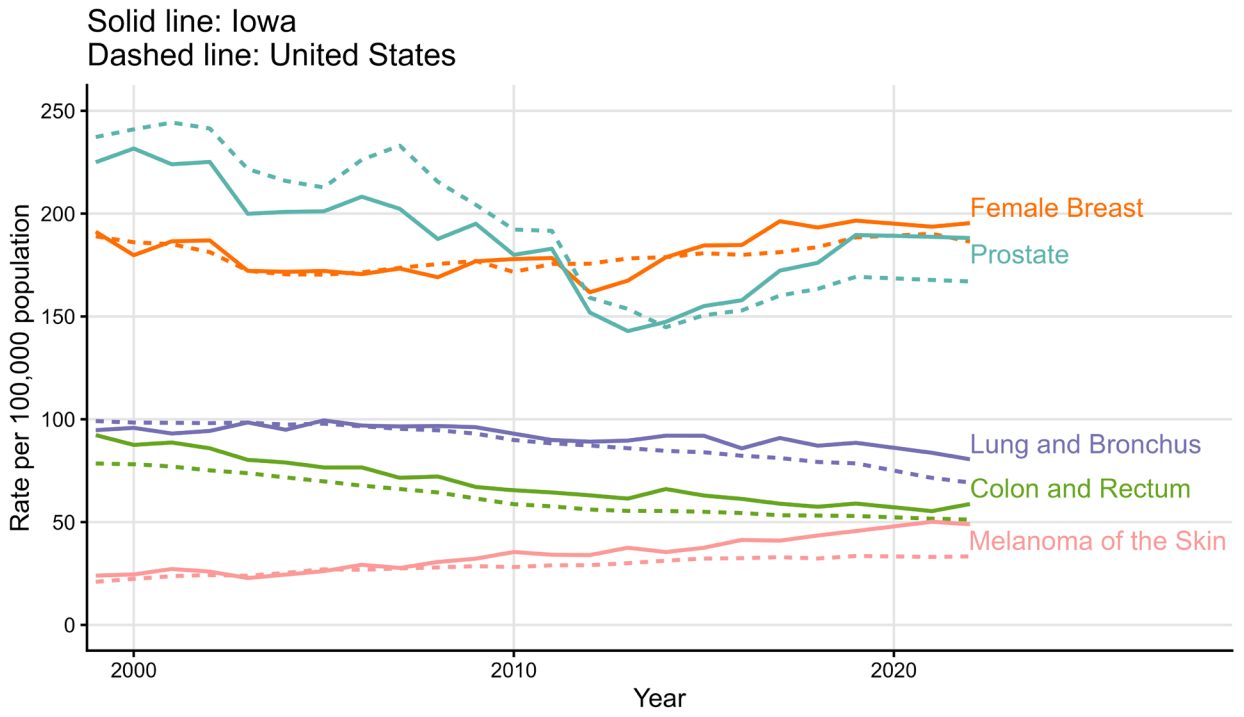
Figure 2. Divergence in cancer incidence trends between Iowa and the U.S., ages 20+, diagnosis years 2013–2022



Data Source: CDC WONDER

Figure 3 and **Figure 4** compare Iowa's incidence and mortality rates, respectively, to U.S. rates for five of the six cancers that are the focus of this project.

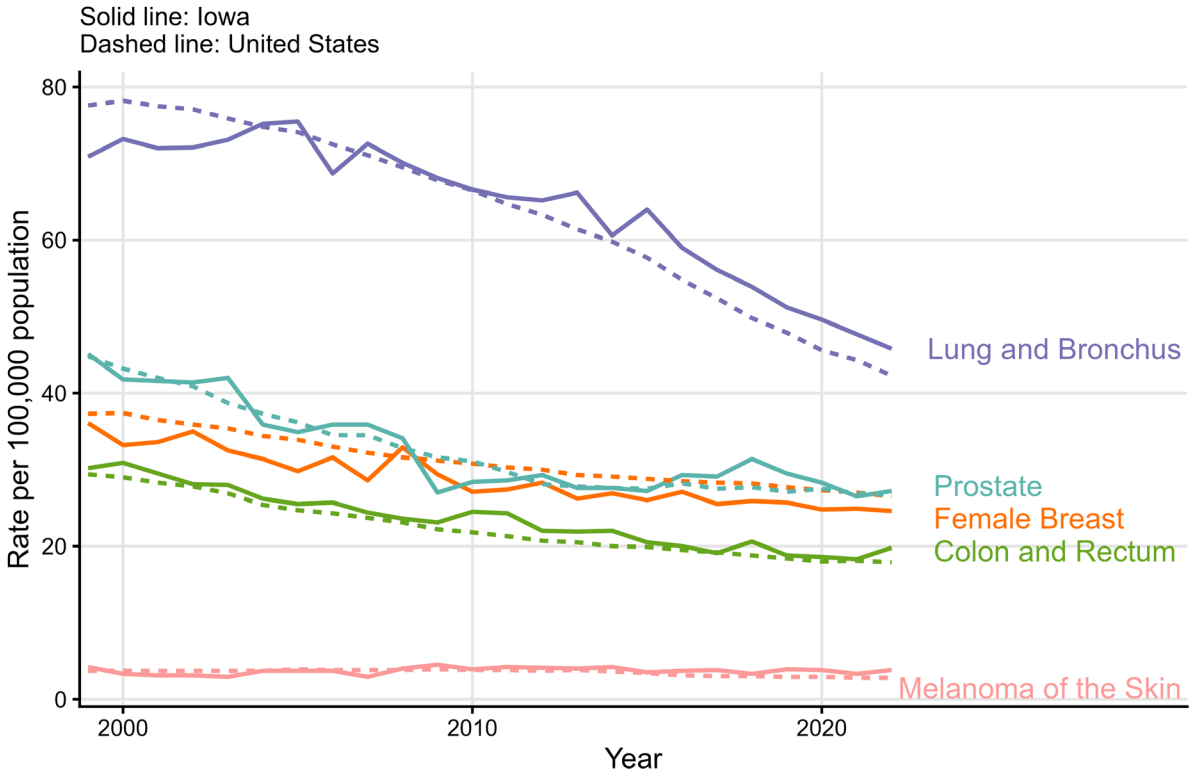
Figure 3. Age-adjusted incidence rates of the **five most common cancers driving Iowa's incidence rates, ages 20+**



Data Source: CDC WONDER

Overall, age-adjusted incidence rates for these five cancer sites are generally higher in Iowa than the U.S. national rates (**Figure 3**). Prostate cancer is an exception in earlier years, with Iowa below the national rate; however, beginning around 2014, prostate cancer incidence in Iowa increased more rapidly than the U.S. trend, and in recent years Iowa's incidence rate has exceeded the national rate.

Figure 4. Age-adjusted mortality rates of the **five most common cancers driving Iowa's incidence rates, ages 20+**

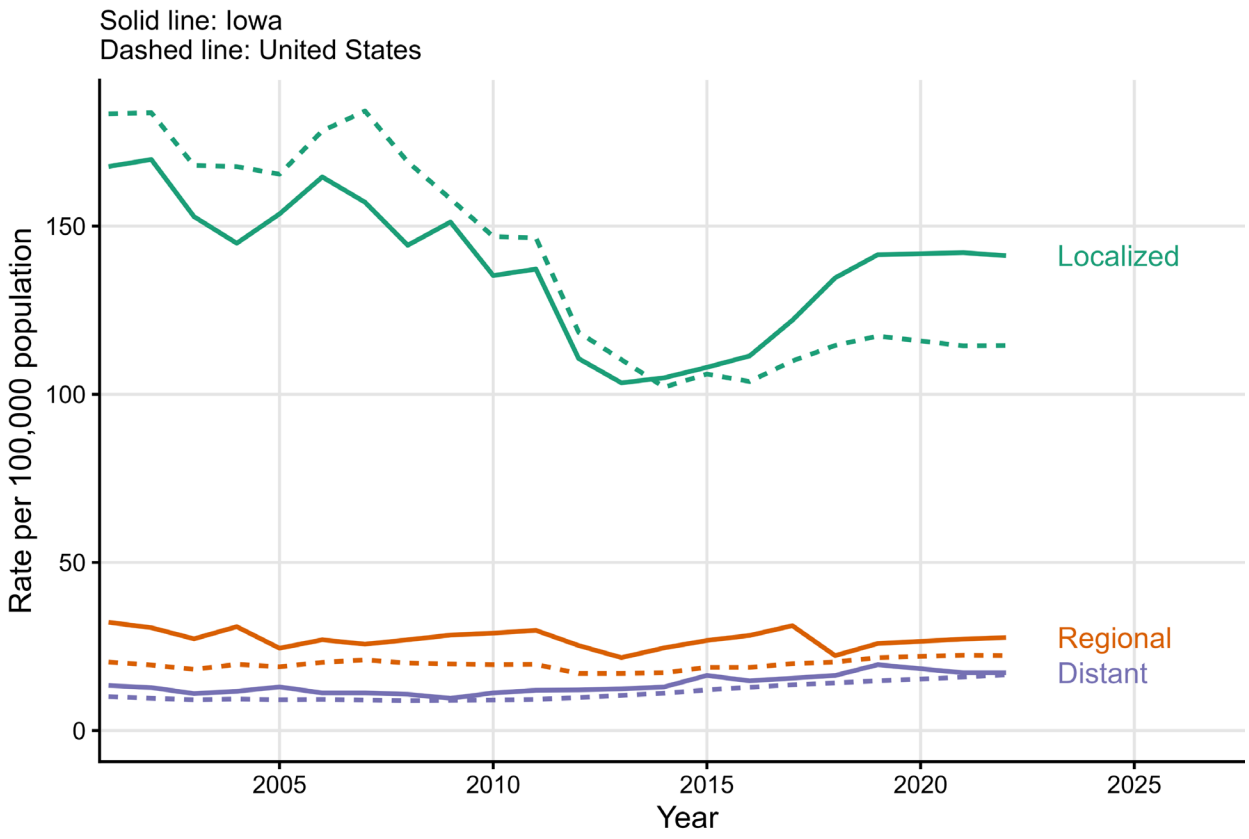


*Data Source: SEER*Stat*

Mortality rates in Iowa closely resemble the national mortality rates, with the exception of lung and bronchus cancer mortality (**Figure 4**). Differences in early detection (i.e., stage at diagnosis), treatment, or survival could contribute to Iowa having an average mortality rate despite its higher incidence rate.

Incidence rates were also examined by cancer stage to understand which stages are contributing to the observed patterns. Results are presented in the following figures. Stage at diagnosis is categorized in three groups: localized (early stage, confined to the primary site), regional (spread to nearby lymph nodes or tissues) and distant (metastatic, spread to distant organs). Stage data were available from 2001–2022.

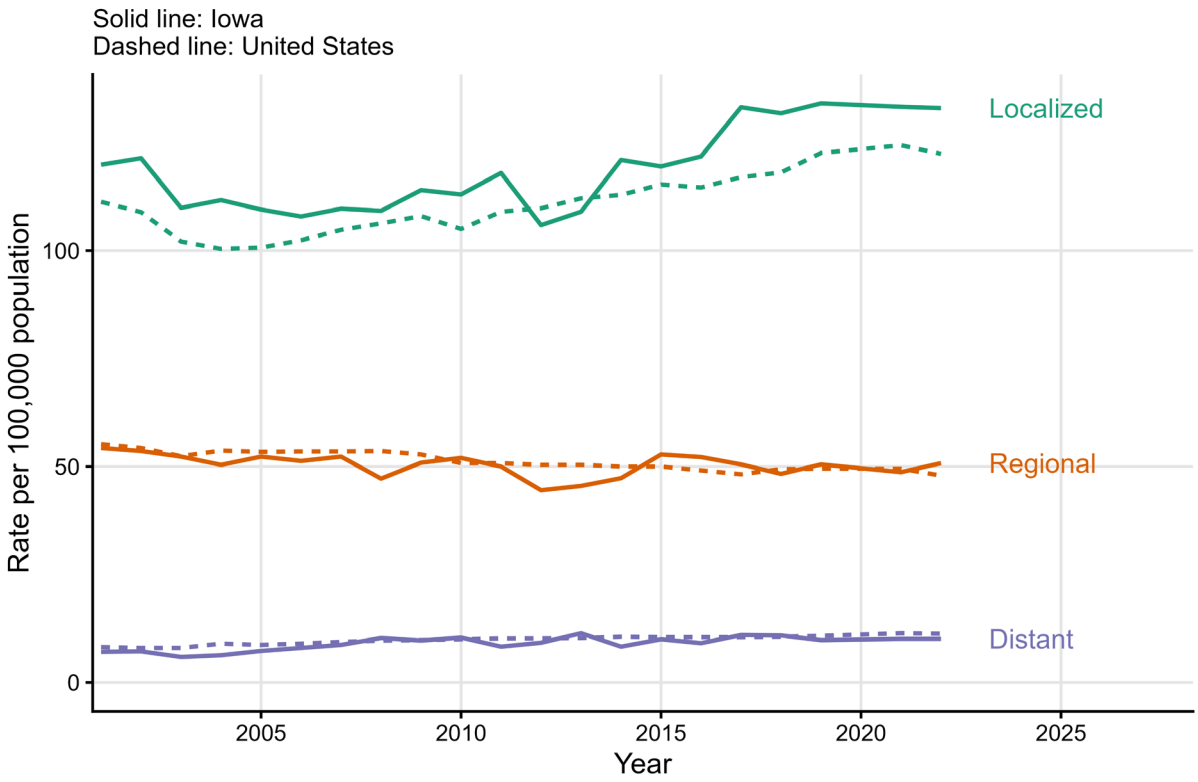
Figure 5. Age-adjusted incidence rates by stage of **prostate cancer, ages 20+**



*Data Source: SEER*Stat*

Figure 3 showed that overall age-adjusted incidence rates for prostate cancer increased rapidly after 2014. Similarly, **Figure 5** shows that localized (early stage) prostate cancer incidence increased sharply from 2014, substantially contributing to the overall increase in prostate cancer incidence. There was a smaller increase in regional and distant stage prostate cancer, and Iowa's rates for these stages generally followed the national trends.

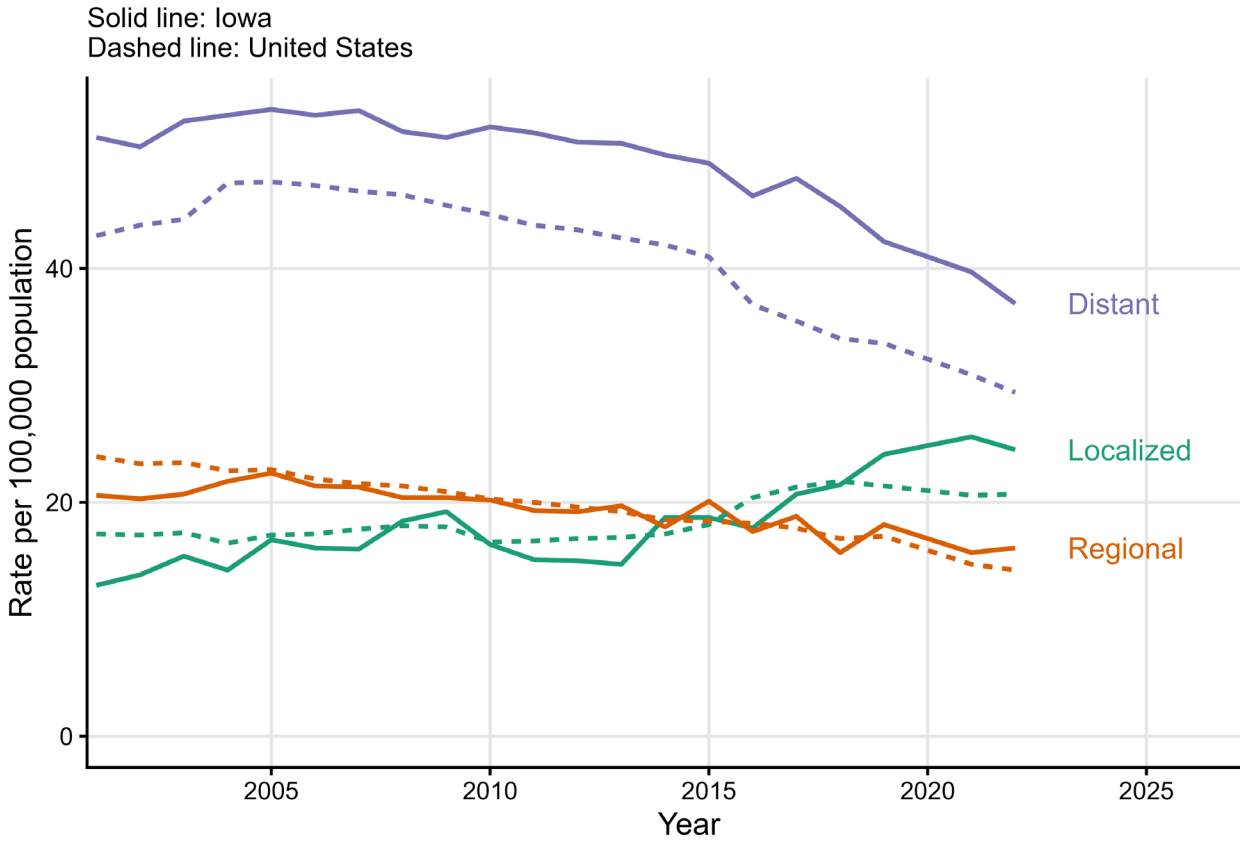
Figure 6. Age-adjusted incidence rates by stage of **female breast cancer, ages 20+**



*Data Source: SEER*Stat*

Age-adjusted incidence rates for localized (early stage) female breast cancer were higher for Iowa compared to U.S. rates, while regional and distant stage incidence rates were similar to national rates (**Figure 6**).

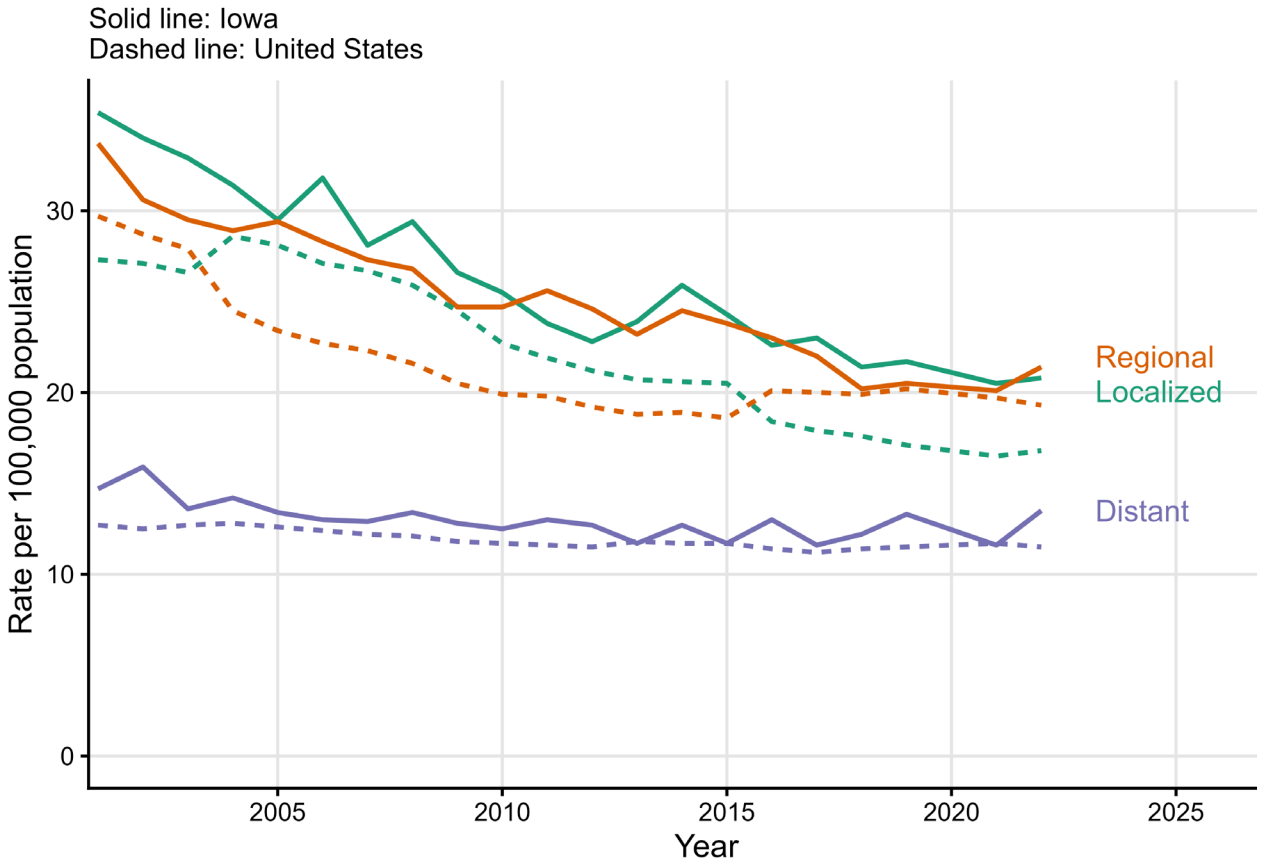
Figure 7. Age-adjusted incidence rates by stage of **lung cancer, ages 20+**



*Data Source: SEER*Stat*

Iowa's rates for localized and regional stage lung cancer were generally similar to U.S. rates, with localized stage incidence beginning to diverge and exceed the U.S. rate starting in 2018 (**Figure 7**). The greatest differential between Iowa and U.S. lung cancer incidence by stage was observed for distant (metastatic) disease where the Iowa rates were consistently higher than the national rates.

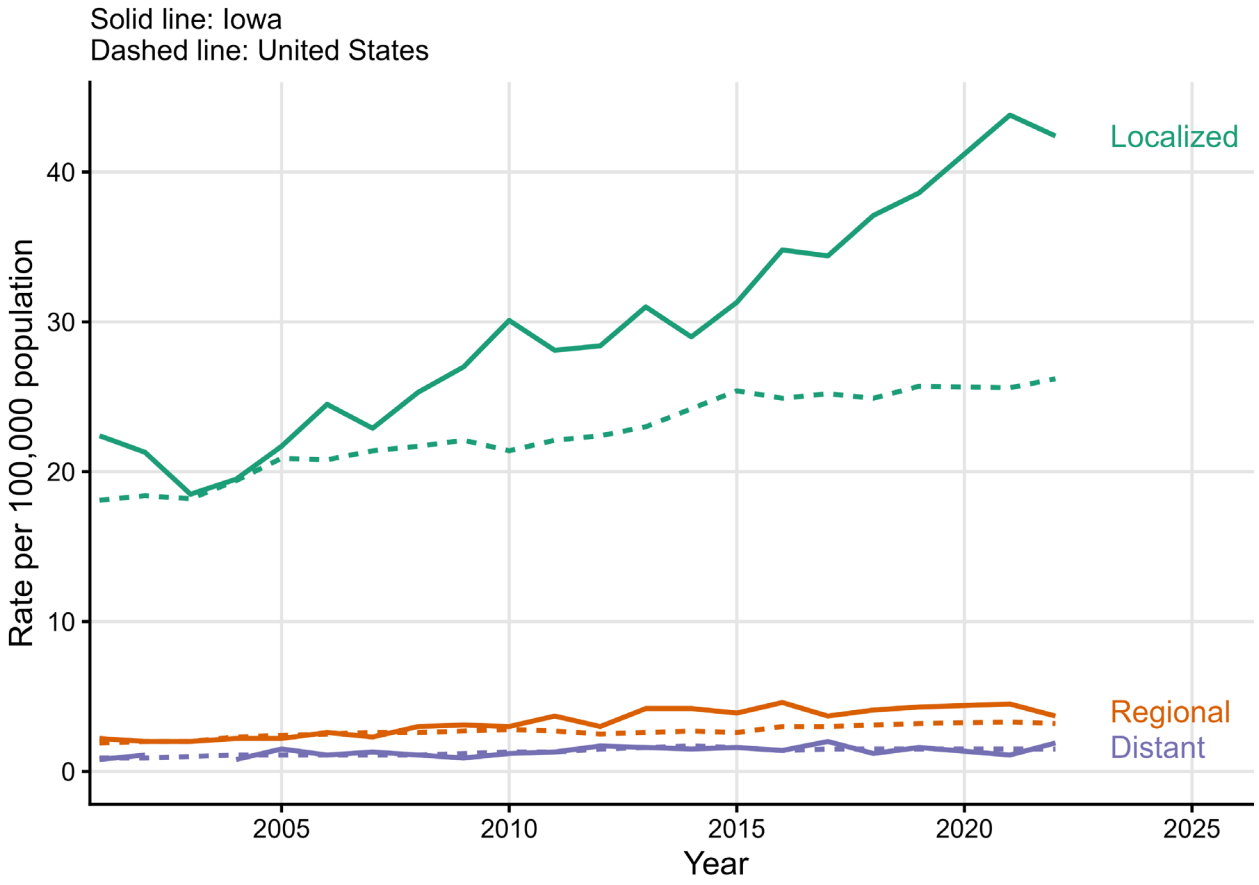
Figure 8. Age-adjusted incidence rates by stage of **colorectal cancer, ages 20+**



*Data Source: SEER*Stat*

Colorectal cancer incidence has declined since 2001 across all stages, with larger reductions observed in regional and localized stages (**Figure 8**). Iowa consistently had higher localized incidence than the U.S., while Iowa's regional stage incidence rate converged with the U.S. rate in 2018, and Iowa's distant stage incidence closely followed the national trend throughout the time period. Iowa's regional and distant stage incidence rates showed an increase in 2021–2022, while the U.S. rates somewhat decreased.

Figure 9. Age-adjusted incidence rates by stage of **melanoma, ages 20+**

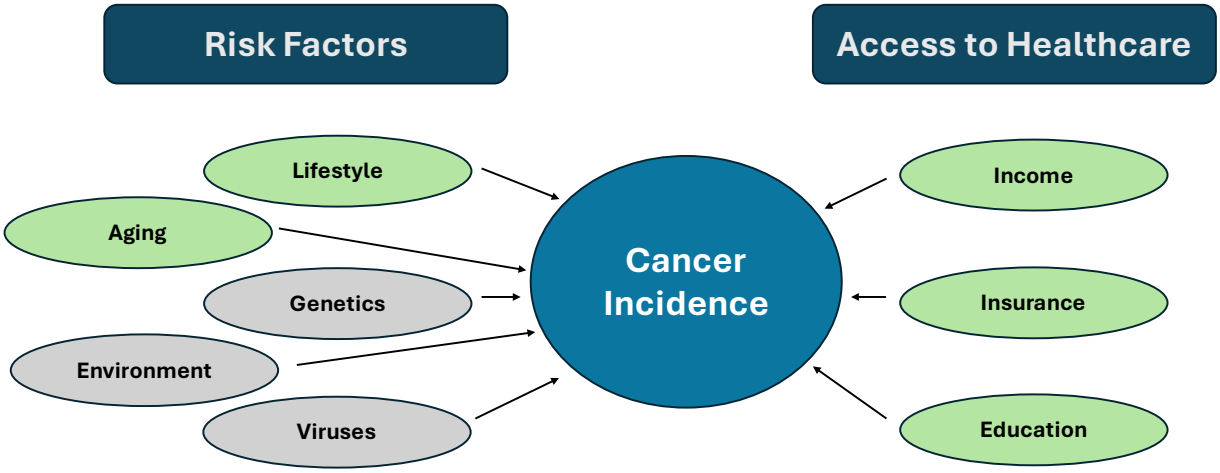


*Data Source: SEER*Stat*

Figure 3 showed that age-adjusted incidence rates for melanoma in Iowa began to increase more rapidly after 2009 compared to the U.S. When examined by stage, localized (early stage) melanoma incidence rates in Iowa show a sharper increase after 2005 compared to the U.S. national trend (**Figure 9**). The Iowa rates for regional and distant stage disease are more similar to the national trends.

While descriptive comparisons of incidence, mortality and stage provide important context, cancer patterns reflect a complex interplay of multiple factors. **Figure 10** shows a conceptual framework summarizing key categories of factors associated with cancer incidence. Green bubbles indicate factors for which data were available and examined in the current analysis, whereas gray bubbles represent factors not yet studied.

Figure 10. Conceptual framework of key categories of factors influencing cancer incidence



While age-adjusted rate comparisons are useful for looking at broader trends, they do not fully explain the complexity of Iowa's cancer burden. We aim to provide a more comprehensive summary than simple rates by examining differences in cancer trends at the most granular level possible. This is done by assessing and combining information across:

- **Multiple data sources**, including cancer incidence from the Iowa Cancer Registry, CDC, State Cancer Profiles, and Surveillance, Epidemiology and End Results (SEER) program, as well as behavioral and demographic risk factors from the Behavioral Risk Factor Surveillance System (BRFSS) and the American Community Survey (ACS);
- **Multiple statistical methods** that allow us to examine the research question from several complementary angles and compile findings that are consistent across approaches;

- **Multiple metrics**, including the derivation of more advanced metrics that go beyond traditional rates or counts previously used in these types of analyses.

We aim to identify when and where cancer incidence were higher or lower than expected by age group. Specifically, we analyzed the data to identify years, age ranges, or geographic regions with elevated cases of cancer that warrant deeper investigation in future analysis.

Data Limitations

While this project used the most complete and reliable data sources available for Iowa and the U.S., several important limitations should be considered:

- **Complexity and incomplete measurement of cancer risk factors.**
  Year 1 analyses are focused on behavioral risk factors and demographic characteristics that are known to be associated with cancer. Other important risk factors such as genetic and environmental exposures will be incorporated in future analyses. The BRFSS does not capture all known behavioral risk factors for cancer and is based on self-reported information.

- **Use of ecological data at the state or county level.**
  Many risk factors and outcome measures were available at the state or county level. As a result, associations observed in this analysis cannot be directly interpreted as individual level relationships.

- **Small population sizes in many counties.**
  County-level analyses, particularly in rural areas, are affected by small population sizes. This can lead to unstable estimates of incidence and risk factors, limiting the ability to precisely characterize cancer trends in smaller counties. BRFSS sampling, for example, is designed to produce stable estimates at the state level but not at the county level.

- **Suppression of national cancer data in certain strata.**
  National cancer data are suppressed when case counts are small, particularly for younger age groups. This limits the precision of national comparisons for these populations.

- **Time lags in data reporting.**
  Cancer incidence and risk factor data are subject to reporting delays, with the most recent available data usually ending in 2022. Data for 2023 are expected to be updated in the first half of 2026.

State Level Comparisons

Calculation of Excess Cases

Age-adjusted rates, while useful, do not reflect all aspects of cancer burden in a community. As such, analyses focused on the number of excess cases observed relative to a national baseline. Excess cases were calculated as the estimated number of additional cancers diagnosed among Iowans compared to the number of cases that would have been diagnosed if Iowa had the same age- and sex-specific cancer rates as the U.S.

Because cancer patterns vary by age, sex, location, and time, the expected calculations were performed at the most granular level possible, incorporating:

- **Age group**: 20–85+, in 5-year groupings
- **Sex**: male or female, as applicable
- **Year**: single years (1999–2022 separately) or multi-year groupings (2008–2012, 2013–2017, and 2018–2022)
- **County**: all 99 Iowa counties

Using this framework,

- **Observed cases** are the actual number of cancer cases in a county per age group, sex, and year reported by the Iowa Cancer Registry
- **Expected cases** represent the number of cases expected in a county per age group, sex, and year if it followed the national rate of cancer

The excess cases metric was then defined as:

$$Excess = Observed - Expected$$

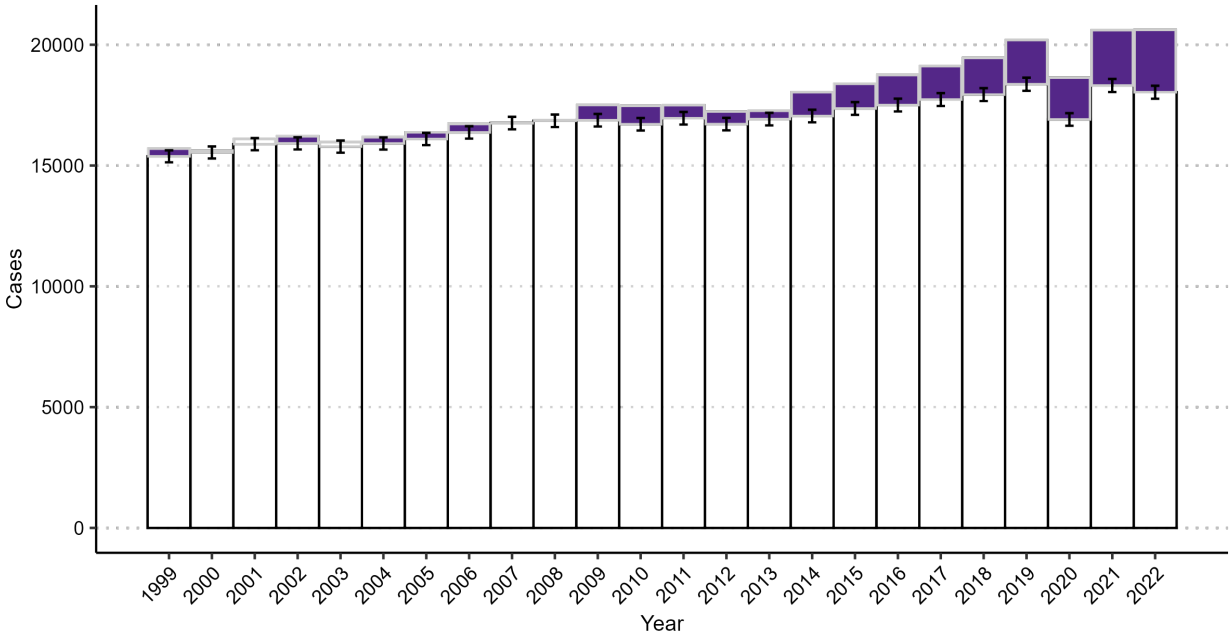
- **Positive excess** indicates a county had more cases than expected based on national rates per age group, sex, and year
- **Negative excess** indicates a county had fewer cases than expected based on national rates per age group, sex, and year

Excess cases are summed across sex and age group to arrive at a county total number of excess cases per year. The counties are summed to compute the statewide number of excess cases.
This excess cases metric was used as a key analytic measure in subsequent analyses, alongside age-adjusted incidence rates.

Estimated Excess Cases Relative to U.S. by Cancer Site over Time

Using the excess cases calculation, Iowa's statewide cancer incidence trends over time were summarized. **Figures 11–20** display yearly observed cancer cases in Iowa compared to the expected number of cases based on national rates along with the resulting excess cases. The error bars for each year represent the normative range (95% confidence interval) around the estimated expected number of cases. Years highlighted in purple indicated positive excess cases above the normative range, meaning the observed number of cancer cases was significantly higher than expected. Years highlighted in yellow indicated negative excess cases below the normative range, meaning the observed number of cancer cases was significantly lower than expected. Years in white fell within the normative range, indicating the observed number of cancer cases was relatively consistent with what would be expected under normal statistical variation.

Figure 11. **All cancer sites, ages 20+**: Observed, expected, and excess cancer cases with 95% confidence intervals

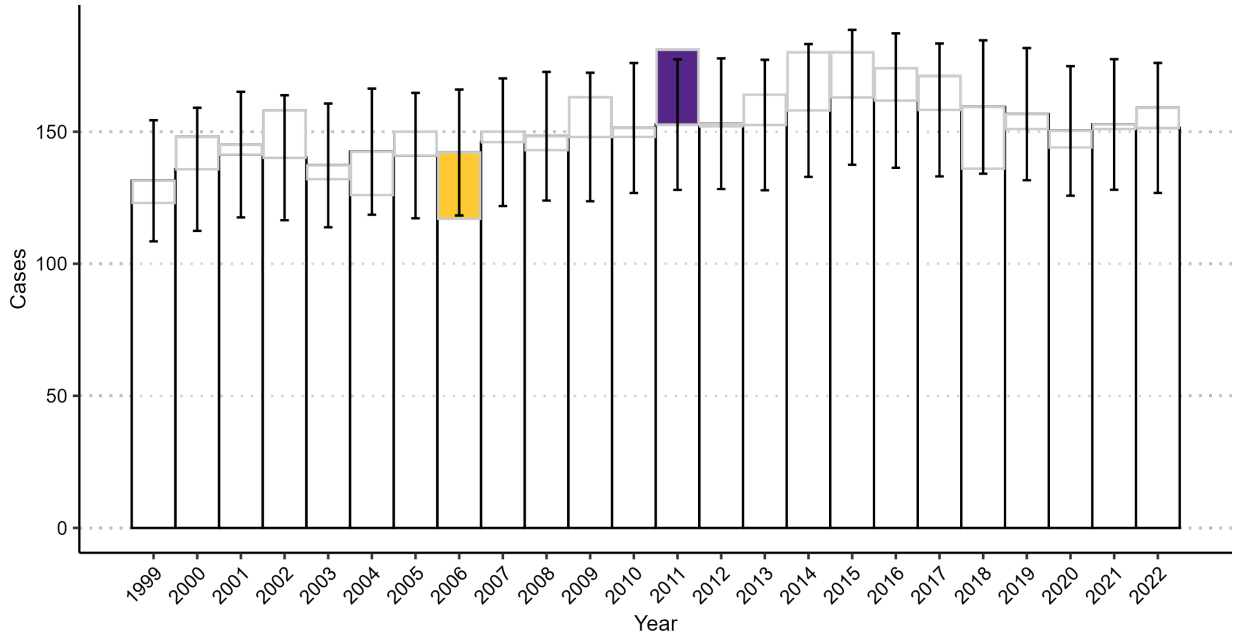


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	15697	15619	16098	16209	15965	16170	16375	16717	16749	16875	17505	17470	17498	17235	17265	18036	18382	18744	19115	19454	20194	18637	20603	20615
Expected	15380	15540	15884	15916	15783	15912	16097	16370	16757	16850	16875	16708	16956	16713	16921	17047	17361	17502	17731	17934	18365	16906	18312	18033
Excess	317	79	214	293	182	258	278	347	-8	25	630	762	542	522	344	989	1021	1242	1384	1520	1829	1731	2291	2582

Data Source: CDC WONDER

For all cancer sites combined (**Figure 11**), **Iowa's observed number of cases were consistently higher than the expected numbers based on national rates for nearly the entire 24-year period**. The only year with slightly fewer cases than expected was 2007 (eight fewer cases observed than expected), which is similar to expectations. Since 2009, excess cases have been consistently above expected. In the most recent year (2022), Iowa had an estimated excess of 2,582 cases statewide, meaning that 2,582 more Iowans were diagnosed with cancer in that year than expected if Iowa's cancer rates matched those observed for the entire U.S.

Figure 12. **All cancer sites, ages <20**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals

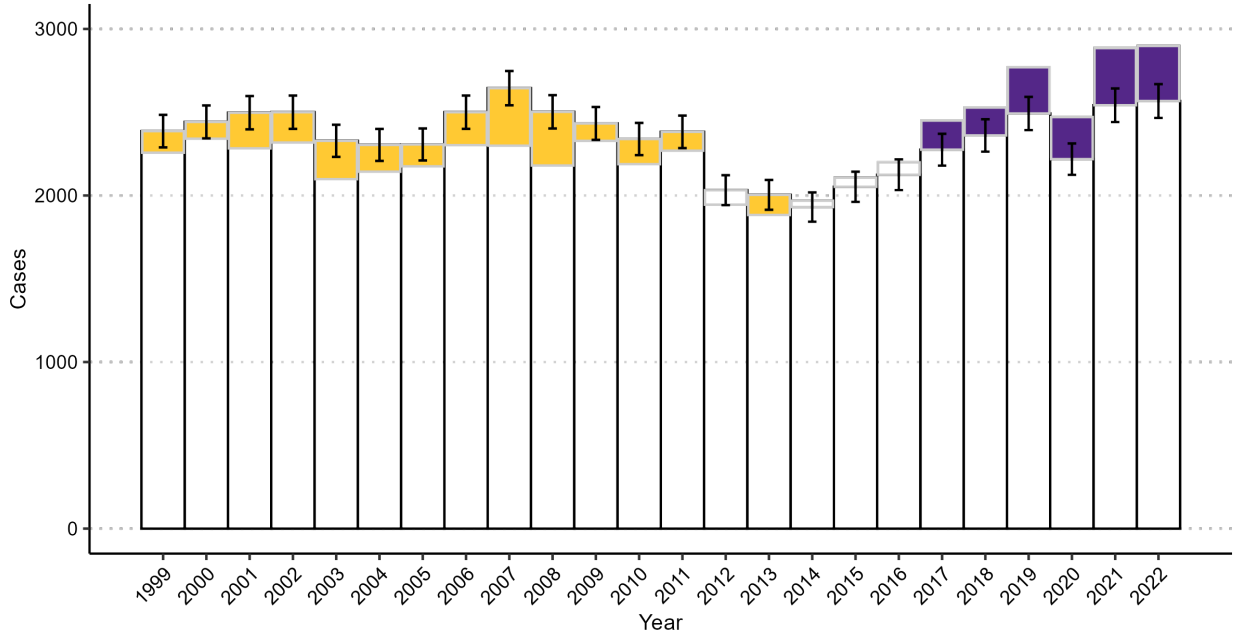


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	123	148	145	158	132	126	150	117	150	143	163	148	181	152	164	180	180	174	171	136	151	144	151	159
Expected	131	136	141	140	137	142	141	142	146	148	148	151	153	153	153	158	163	162	158	159	157	150	153	151
Excess	-8	12	4	18	-5	-16	9	-25	4	-5	15	-3	28	-1	11	22	17	12	13	-23	-6	-6	-2	8

Data Source: CDC WONDER

For individuals under age 20 (**Figure 12**), cancer incidence in Iowa closely tracked national expectations over time, with occasional deviations (e.g. 25 fewer cases than expected in 2006 and 28 more cases than expected in 2011) but no sustained pattern of excess.

Figure 13. **Prostate cancer, ages 20+**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals

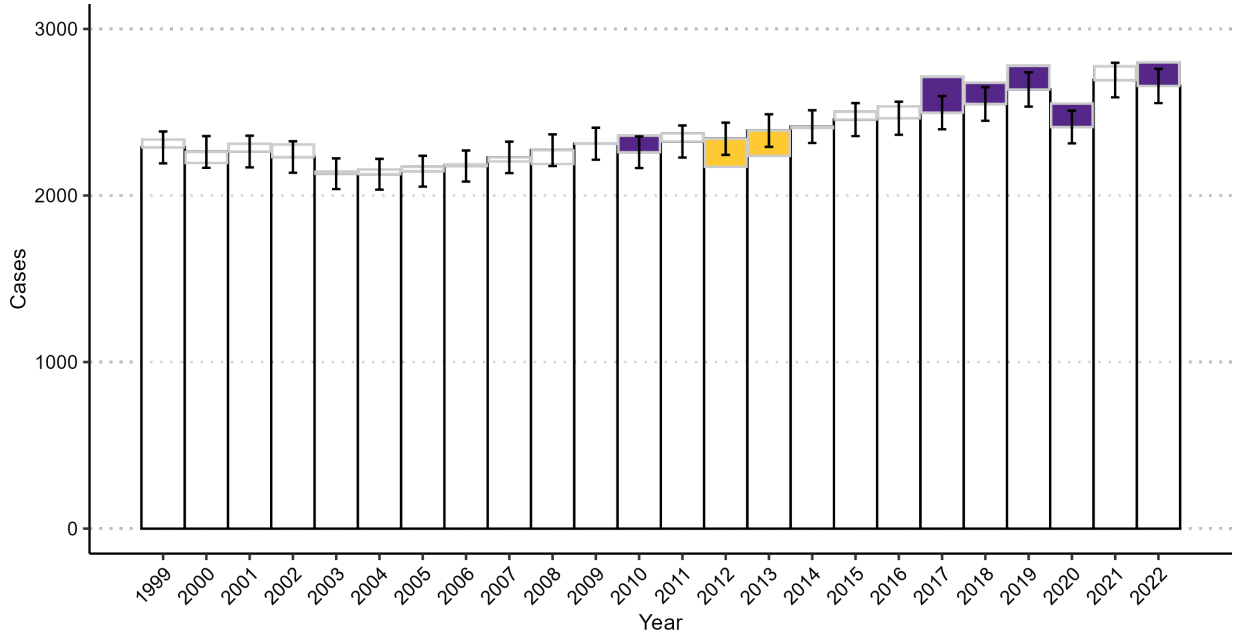


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	2257	2341	2283	2318	2098	2143	2175	2302	2299	2180	2328	2188	2269	1945	1883	1969	2107	2199	2450	2528	2770	2471	2885	2898
Expected	2387	2442	2497	2500	2328	2304	2306	2500	2645	2502	2433	2339	2382	2032	2004	1931	2052	2124	2275	2361	2492	2218	2542	2567
Excess	-130	-101	-214	-182	-230	-161	-131	-198	-346	-322	-105	-151	-113	-87	-121	38	55	75	175	167	278	253	343	331

Data Source: CDC WONDER

From 1999 through 2011, Iowa's prostate cancer cases were below expected based on national trends (**Figure 13**). Around 2014, excess cases began to rise, though they mostly remained within the expected range up until 2016. Beginning in 2017, Iowa's excess prostate cancer counts moved above the expected range, indicating a shift toward higher-than-expected incidence. In the most recent year for which data were available (2022), Iowa had an estimated excess of 331 prostate cancer cases statewide, meaning that 331 more Iowans were diagnosed with prostate cancer in that year than expected if Iowa's prostate cancer rate matched the observed rate for the entire U.S.

Figure 14. **Female breast cancer, ages 20+**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals



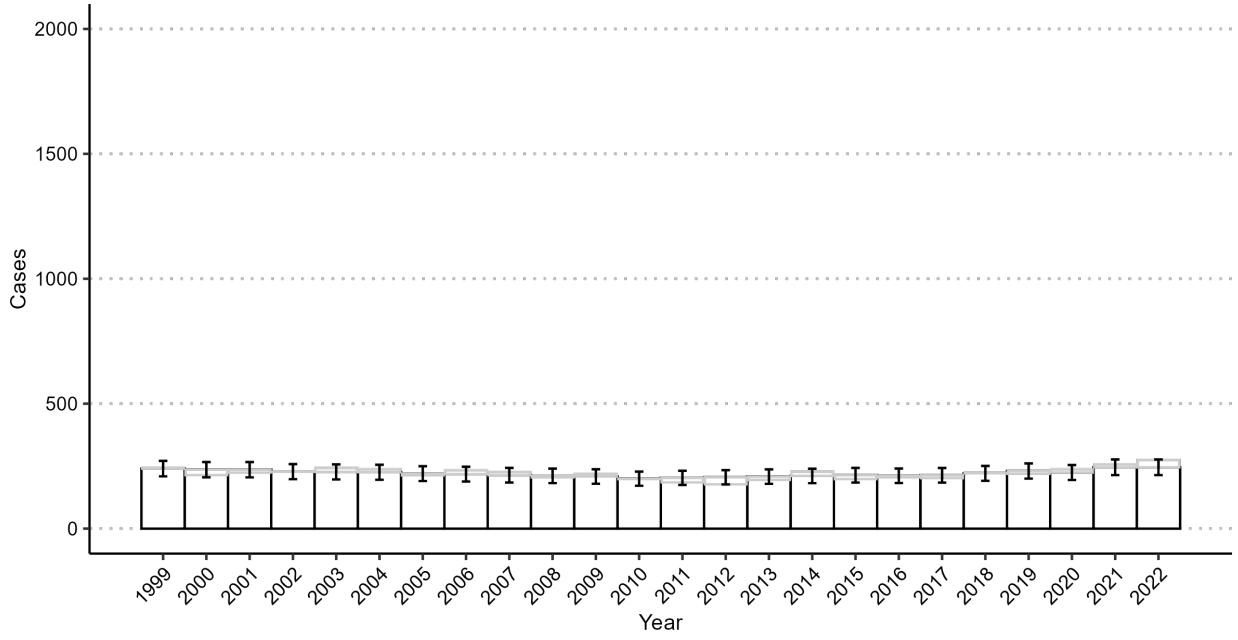
Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	2336	2195	2311	2306	2143	2156	2172	2186	2204	2189	2312	2359	2373	2172	2238	2404	2503	2535	2712	2677	2778	2552	2775	2799
Expected	2289	2262	2264	2231	2130	2128	2146	2177	2229	2272	2311	2260	2324	2341	2390	2414	2456	2464	2497	2550	2636	2411	2693	2658
Excess	47	-67	47	75	13	28	26	9	-25	-83	1	99	49	-169	-152	-10	47	71	215	127	142	141	82	141

Data Source: CDC WONDER

For female breast cancer among ages 20+, Iowa's observed cases were generally close to or slightly above expected levels from 1999 through 2011 (**Figure 14**). In 2012 and 2013, cases dipped below expected levels but returned to within the expected range the following year. Starting in 2017 and through 2022, cases were above expected. Overall, female breast cancer shows elevated excess in some earlier years followed by a pattern of consistently elevated excess starting in 2017. In the most recent year for which data were available (2022), Iowa had an estimated excess of 141 female breast cancer cases statewide, meaning that 141 more Iowa females were diagnosed with breast cancer in that year than expected if Iowa's female breast cancer rate matched the observed rate for the entire U.S.

Since female breast cancer behaves differently before and after menopause, the following two figures apply the same excess case framework to pre- and postmenopausal breast cancer incidence by using age groups 20–44 and 55+, respectively, to define these categories.

Figure 15. **Premenopausal breast cancer, ages 20–44**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals

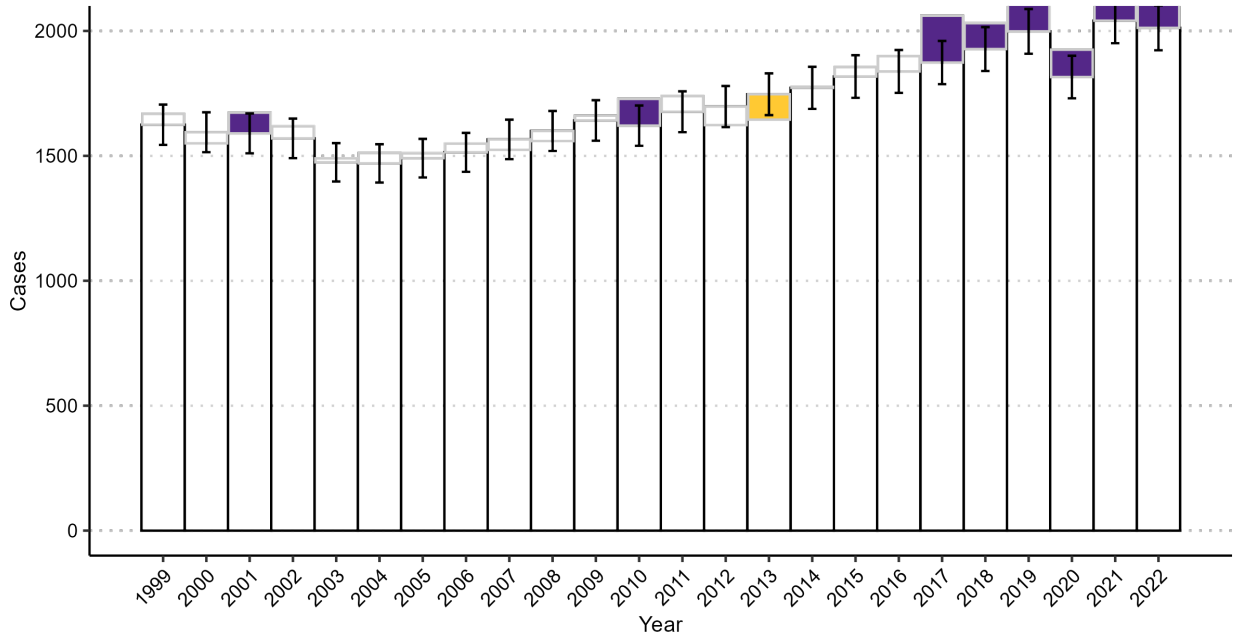


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	242	214	224	228	242	237	213	233	226	205	218	198	185	177	195	227	198	205	202	223	219	237	257	274
Expected	240	236	236	228	227	226	220	218	214	211	209	200	203	205	208	211	214	212	214	221	231	225	246	245
Excess	2	-22	-12	0	15	11	-7	15	12	-6	9	-2	-18	-28	-13	16	-16	-7	-12	2	-12	12	11	29

Data Source: CDC WONDER

For premenopausal breast cancer among females ages 20–44, observed cases in Iowa closely followed the expected number based on national trends (**Figure 15**). The most recent year had 29 excess cases, and no year had an excess below or above the expected range. Overall, breast cancer incidence among premenopausal females appears stable over time.

Figure 16. **Postmenopausal breast cancer, ages 55+**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals

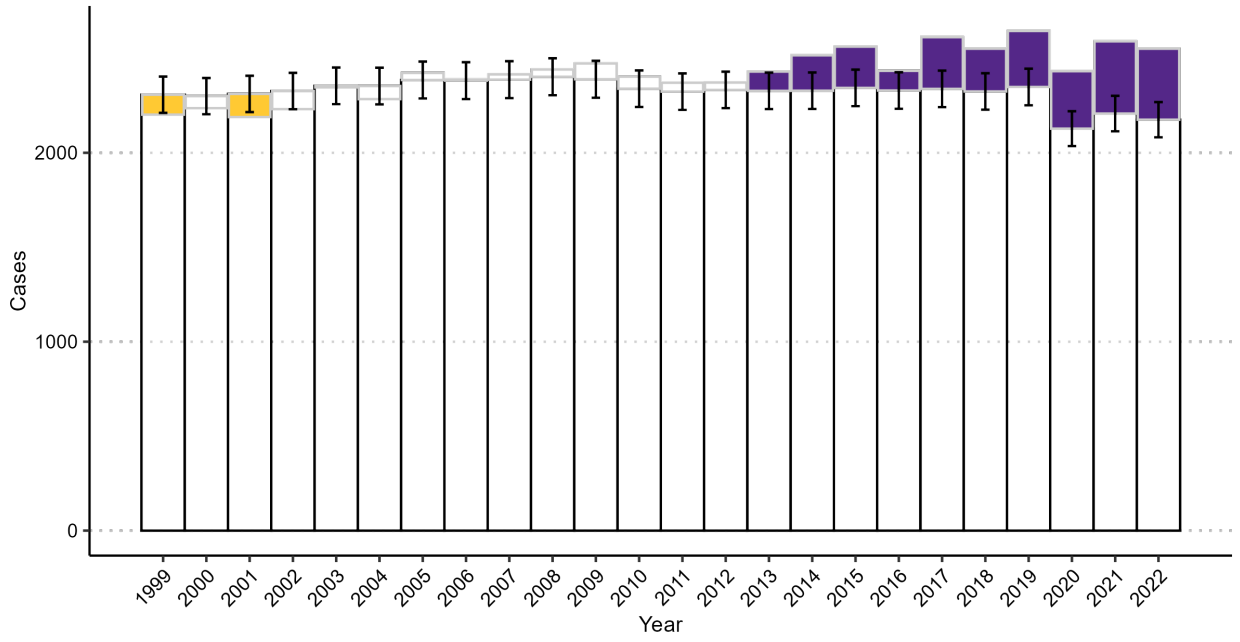


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	1668	1550	1673	1618	1490	1511	1510	1549	1524	1559	1661	1728	1739	1623	1645	1776	1855	1899	2061	2031	2138	1925	2140	2119
Expected	1625	1595	1590	1570	1474	1470	1491	1514	1566	1600	1642	1621	1676	1697	1747	1772	1818	1838	1873	1927	1998	1816	2041	2012
Excess	43	-45	83	48	16	41	19	35	-42	-41	19	107	63	-74	-102	4	37	61	188	104	140	109	99	107

Data Source: CDC WONDER

For postmenopausal breast cancer among females ages 55+, Iowa's observed cases were generally close to or slightly above expected levels from 1999 through 2012 (**Figure 16**). After a dip below expected cases in 2013, excess began increasing and then exceeded the expected range from 2017 through 2022, reaching 107 excess cases in 2022.

Figure 17. **Lung cancer, ages 20+**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals

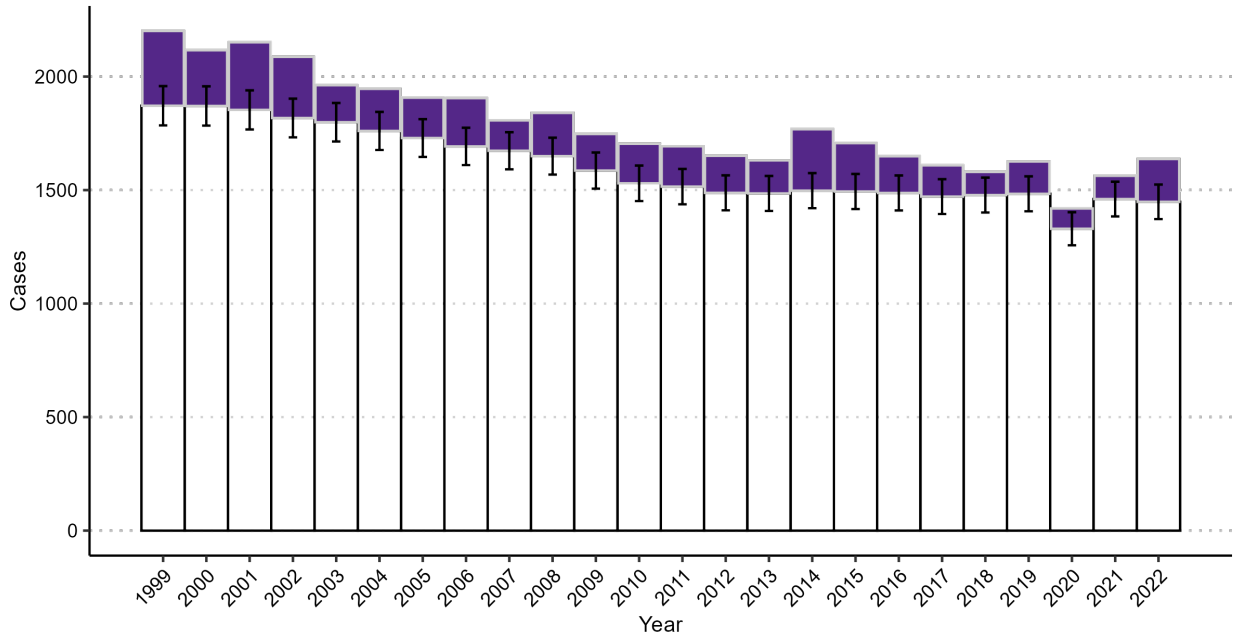


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	2202	2236	2189	2231	2346	2284	2423	2388	2415	2441	2473	2403	2371	2372	2430	2516	2562	2434	2612	2551	2645	2432	2590	2551
Expected	2307	2300	2312	2327	2354	2353	2385	2382	2387	2402	2389	2339	2324	2333	2328	2329	2343	2330	2338	2325	2348	2128	2208	2175
Excess	-105	-64	-123	-96	-8	-69	38	6	28	39	84	64	47	39	102	187	219	104	274	226	297	304	382	376

Data Source: CDC WONDER

From 1999–2012, the number of lung cancer cases in Iowa was generally below or within the normative range of expected cases (**Figure 17**). Starting in 2013, excess cases increased and remained consistently above the expected range through 2022. In the most recent year for which data were available (2022), Iowa had an estimated excess of 376 lung cancer cases statewide, meaning that 376 more Iowans were diagnosed with lung cancer in that year than expected if Iowa's lung cancer rate matched the observed rate for the entire U.S.

Figure 18. **Colorectal cancer, ages 20+**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals

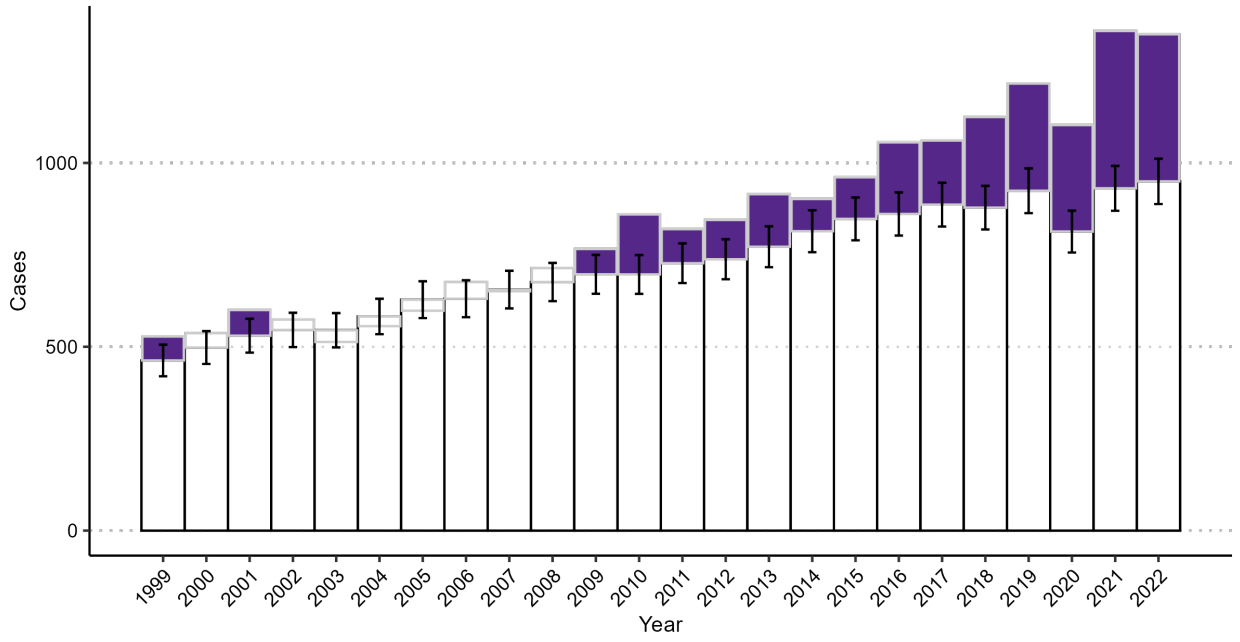


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	2201	2116	2151	2087	1962	1946	1907	1905	1807	1840	1747	1704	1693	1651	1631	1768	1707	1649	1609	1580	1626	1419	1563	1637
Expected	1871	1871	1853	1817	1799	1761	1729	1692	1673	1650	1586	1530	1515	1488	1485	1497	1494	1487	1471	1478	1483	1330	1460	1448
Excess	330	245	298	270	163	185	178	213	134	190	161	174	178	163	146	271	213	162	138	102	143	89	103	189

Data Source: CDC WONDER

While the colorectal cancer incidence rate in Iowa has declined generally in parallel with the U.S. rate, observed colorectal case counts in Iowa have exceeded expected levels based on national trends every year from 1999 through 2022 (**Figure 18**). In the most recent year for which data were available (2022), Iowa had an estimated excess of 189 colorectal cancer cases statewide, meaning that 189 more Iowans were diagnosed with colorectal cancer in that year than expected if Iowa's colorectal cancer rate matched the observed rate for the entire U.S.

Figure 19. **Melanoma, ages 20+**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals

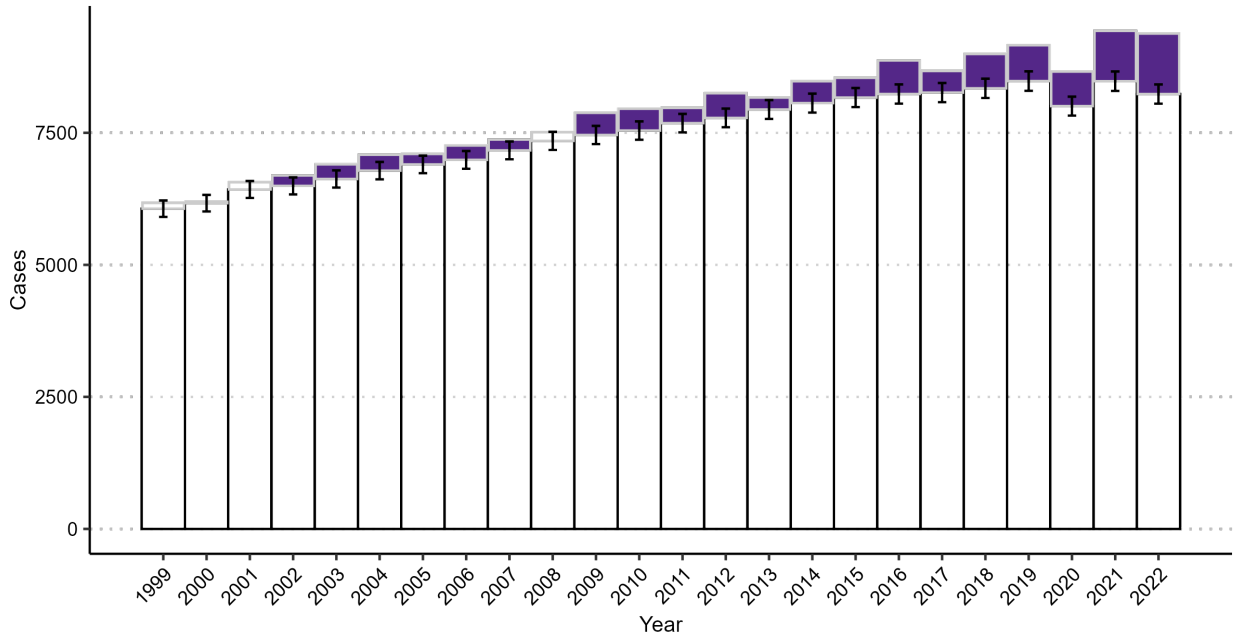


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	528	537	600	574	513	556	598	676	651	714	766	860	820	845	915	902	961	1056	1061	1125	1216	1103	1359	1350
Expected	463	498	530	546	545	582	628	631	656	676	697	697	727	738	772	814	848	861	887	878	924	813	931	950
Excess	65	39	70	28	-32	-26	-30	45	-5	38	69	163	93	107	143	88	113	195	174	247	292	290	428	400

Data Source: CDC WONDER

Cases of melanoma have been generally increasing in Iowa since 1999 (**Figure 19**). Starting in 2009 and continuing through 2022, cases of melanoma were above expected, with the number of excess cases increasing over time. In the most recent year for which data were available (2022), Iowa had an estimated excess of 400 melanoma cases statewide, meaning that 400 more Iowans were diagnosed with melanoma in that year than expected if Iowa's melanoma rate matched the observed rate for the entire U.S.

Figure 20. **Other cancers, ages 20+**: Iowa's observed, expected, and excess cancer cases with 95% confidence intervals



Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	6173	6194	6564	6693	6903	7085	7100	7260	7373	7511	7879	7956	7972	8250	8168	8477	8542	8871	8671	8993	9159	8660	9431	9380
Expected	6063	6168	6428	6495	6626	6784	6902	6988	7168	7348	7459	7543	7683	7783	7942	8063	8168	8236	8262	8343	8480	8006	8478	8235
Excess	110	26	136	198	277	301	198	272	205	163	420	413	289	467	226	414	374	635	409	650	679	654	953	1145

Data Source: CDC WONDER

The previous five site-specific cancers make up around 56% of Iowa's excess cases, as shown in **Table 3**. **Figure 20** depicts excess cases for all remaining cancer sites combined. Observed case counts for these other cancers were consistently above expected levels from 2002 through 2022, with the exception of 2008, which fell within the expected range. In the most recent year for which data were available (2022), Iowa had an estimated excess of 1,145 cases of other cancer types statewide, meaning that 1,145 more Iowans were diagnosed with other cancers in that year than expected if Iowa's rate of other cancers matched the observed rate for the entire U.S.

Table 3. Iowa's excess cancer cases by cancer site relative to the U.S. in 2022

Cancer.Site	**Excess Cases**	**Percent of Excess Cases**
Prostate	331	12.8%
Female Breast	141	5.5%
Lung	376	14.6%
Colorectal	189	7.3%
Melanoma	400	15.5%
Other	1,145	44.3%
Total	**2,582**	**100%**

Table 3 summarizes the excess cases in Iowa for 2022. In 2022, Iowa experienced the most excess cases relative to the U.S. from melanoma followed by excess cases in lung, prostate, colorectal, and female breast cancers. Melanoma and lung cancers by themselves accounted for 30% of all of Iowa's excess cases.

State Clusters of Demographic and Behavioral Risk Factors

One goal of these analyses was to identify potential reasons why Iowa's cancer rates differ from other states. Our first step toward this goal was to evaluate which states are most similar to Iowa based on currently available data of demographic characteristics and self-reported behavioral risk factors.

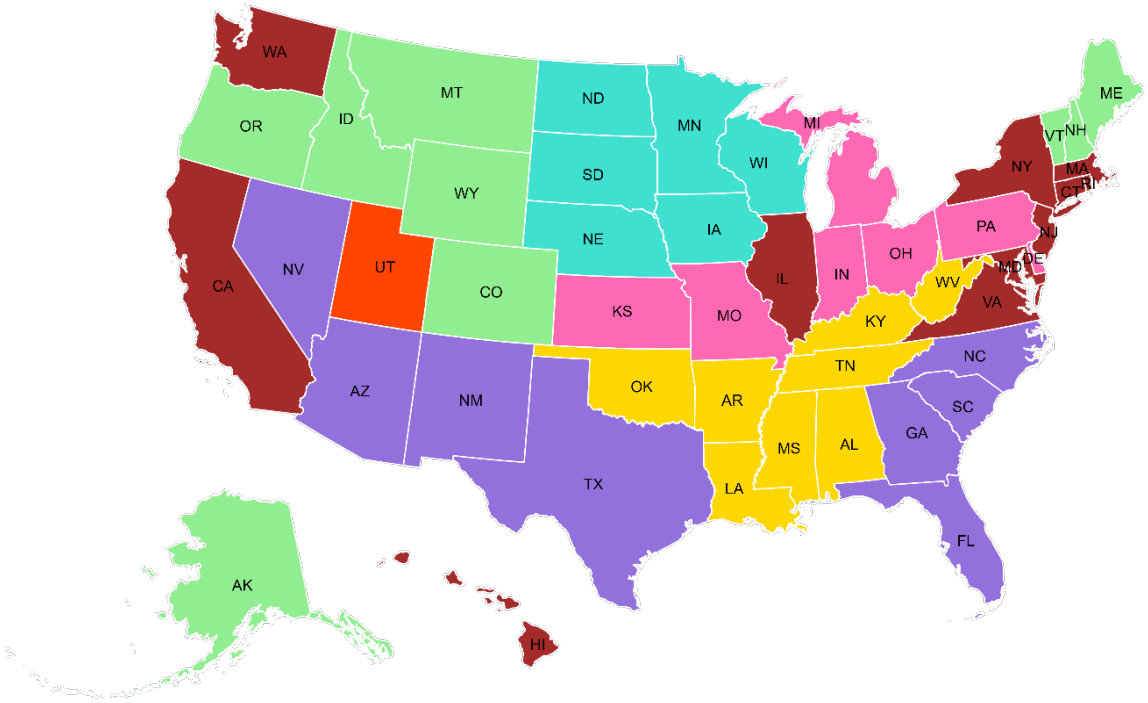
Self-reported behavioral risk factor variables included measures of alcohol use, smoking, exercise and physical inactivity, diet-related indicators, obesity, and preventive care. Demographic and socioeconomic variables included state-level educational attainment (i.e., percent with bachelor's degree), unemployment, insurance coverage, median household income, and poverty rate. All variables were aggregated from 2018–2022 and standardized to ensure comparable scale prior to clustering.

A clustering algorithm was used to group the 50 U.S. states into an optimized number of clusters, where each cluster contained the states with the most similar risk factor profiles. States were assigned to clusters by minimizing differences in average values for each potential cancer risk factor or demographic characteristic, resulting in seven groupings of states with similar risk profiles.

These seven exploratory groupings correspond to the color-coded clusters shown in **Figure 21** and reflect similarities in demographic characteristics and self-reported behavioral risk factors across geographic regions. The clusters were used to inform future analyses linking risk factors to cancer outcomes. For example, if a cluster of states all had high smoking

rates, all the states within that cluster could be expected to also have high rates of lung cancer.

Figure 21. Seven identified state clusters based on behavioral risk factors and demographic characteristics



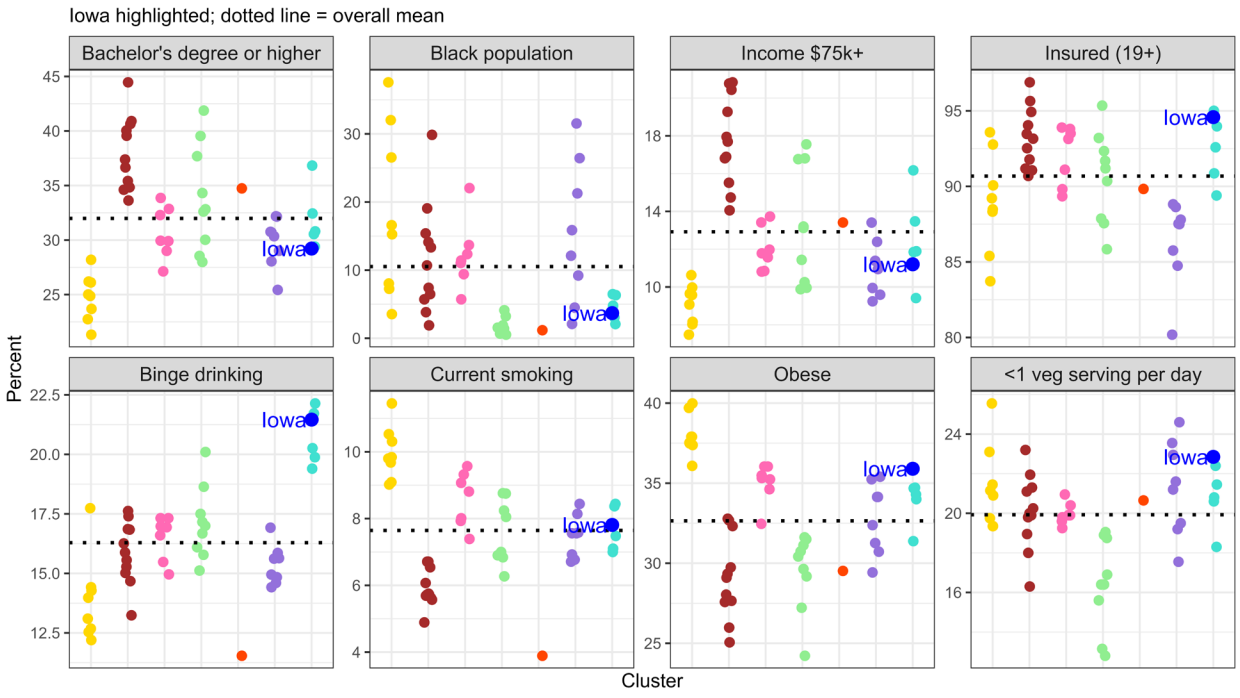
The clustering analysis grouped states into seven broad groups with similar demographic and behavioral profiles.

- Cluster 1 – AL, AR, KY, LA, MS, OK, TN, WV (yellow): States with lower socioeconomic status (SES) and higher health-risk behaviors, including higher obesity and cigarette smoking rates.
- Cluster 2 – CA, CT, HI, IL, MD, MA, NJ, NY, RI, VA, WA (dark red): States with higher SES and generally favorable health behaviors, including lower obesity and higher fruit intake.
- Cluster 3 – DE, IN, KS, MI, MO, OH, PA (pink): States with moderate SES but elevated obesity and smoking.
- Cluster 4 – AK, CO, ID, ME, MT, NH, OR, VT, WY (green): States with above-average SES and generally healthier behaviors but higher levels of binge drinking.
- Cluster 5 – UT (red): A single-state cluster characterized by very low cigarette smoking and drinking rates and overall healthier lifestyle patterns, with average SES.

- Cluster 6 - AZ, FL, GA, NV, NC, NM, SC, TX (purple): States with lower SES and lower insurance coverage and mixed behavioral risk factors.
- **Cluster 7 – IA**, MN, NE, ND, SD, WI (turquoise): States with higher insurance coverage and average SES, but also high levels of drinking and obesity.

Figure 22 displays how several key behavioral and demographic characteristics vary across states and their clusters. This information can be used to understand why the states were grouped together into their respective clusters. Each panel reveals the distribution of a selected population or behavioral characteristic across U.S. states. States were grouped and colored on the x-axis to match clusters in **Figure 21** and the percentage of the state population with that characteristic are shown on the y-axis. Each dot represents a state; Iowa is highlighted in blue, and the black dotted horizontal line denotes the national average. This visualization illustrates how Iowa and its cluster compare with other states and clusters.

Figure 22. State level characteristics by cluster (2018–2022)



Data Source: BRFSS, ACS

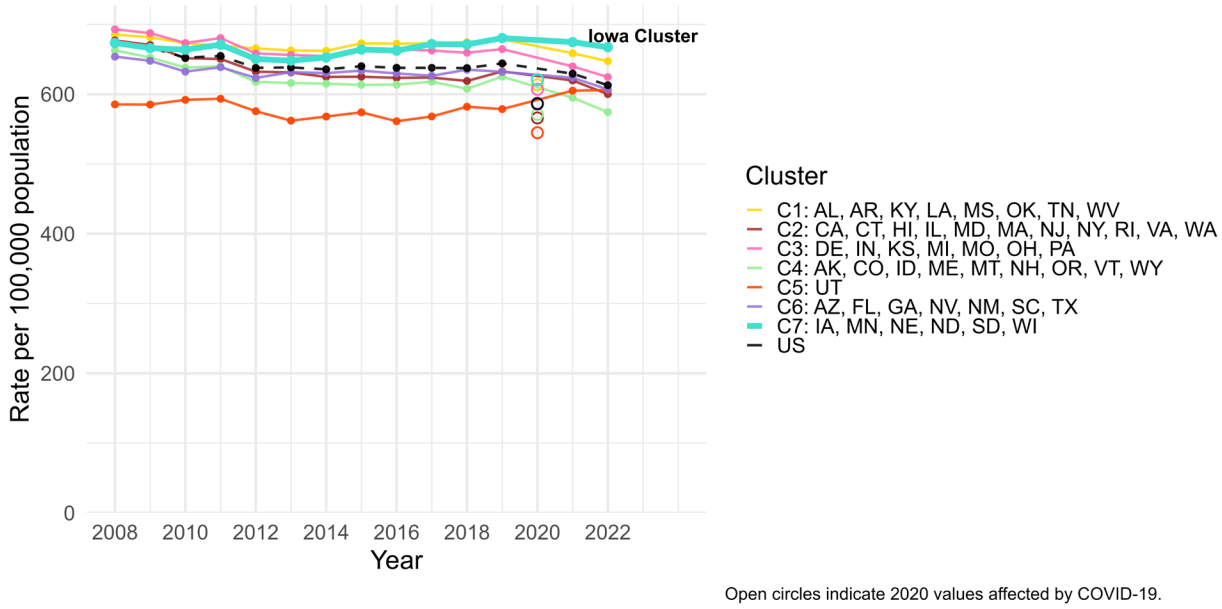
Among the six states in Iowa's cluster, Iowa generally fell on the higher-risk end of several behaviors. Iowa was among the top 3 states in the cluster for binge drinking. Iowa had the highest percentage obese within the cluster. Iowa was also the highest state within the cluster for people who do not eat at least one serving of vegetables daily. Iowa's current smoking was near average within the cluster, and the percentage with an annual income of

$75,000+ was slightly below average. Iowa had a lower percentage of adults with at least a bachelor's degree compared to other states in their cluster. The entire cluster had a low percentage of Black residents. Iowa was higher than other states within the cluster for people with insurance.

Cancer Incidence Trends by State Clusters

After identifying clusters of states at the national level, cancer incidence trends were plotted (using either age-adjusted incidence rate and/or the excess cases metric) to examine how similar or different cancer incidence trends were by cluster. **Figures 23–29** show the age-adjusted incidence rate for each cluster and specific cancer type. Data shown for 2008–2022.

Figure 23. **All cancer sites, ages 20+**: Age-adjusted incidence rates by state clusters

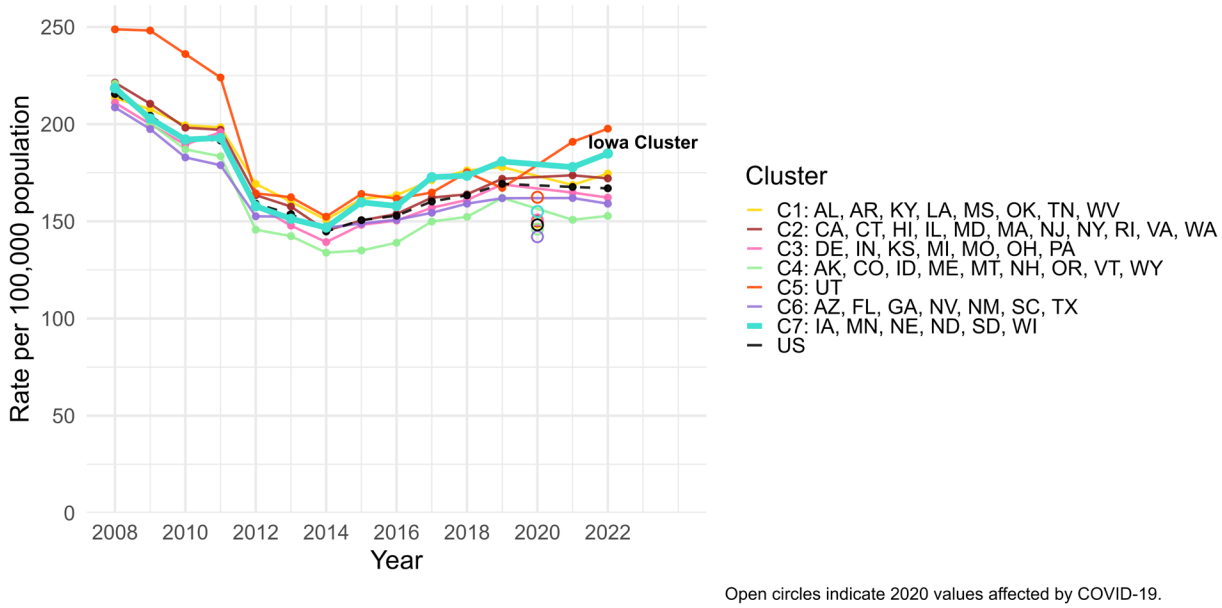


Open circles indicate 2020 values affected by COVID-19.

Data Source: CDC WONDER

Overall, Iowa's cluster showed increasing trends in age-adjusted incidence rates for all cancer sites starting from 2014 through 2019 (**Figure 23**). In 2022, Iowa's cluster of states had the highest rate for all cancer sites combined among all clusters of states in the U.S. (667 per 100,000 population).

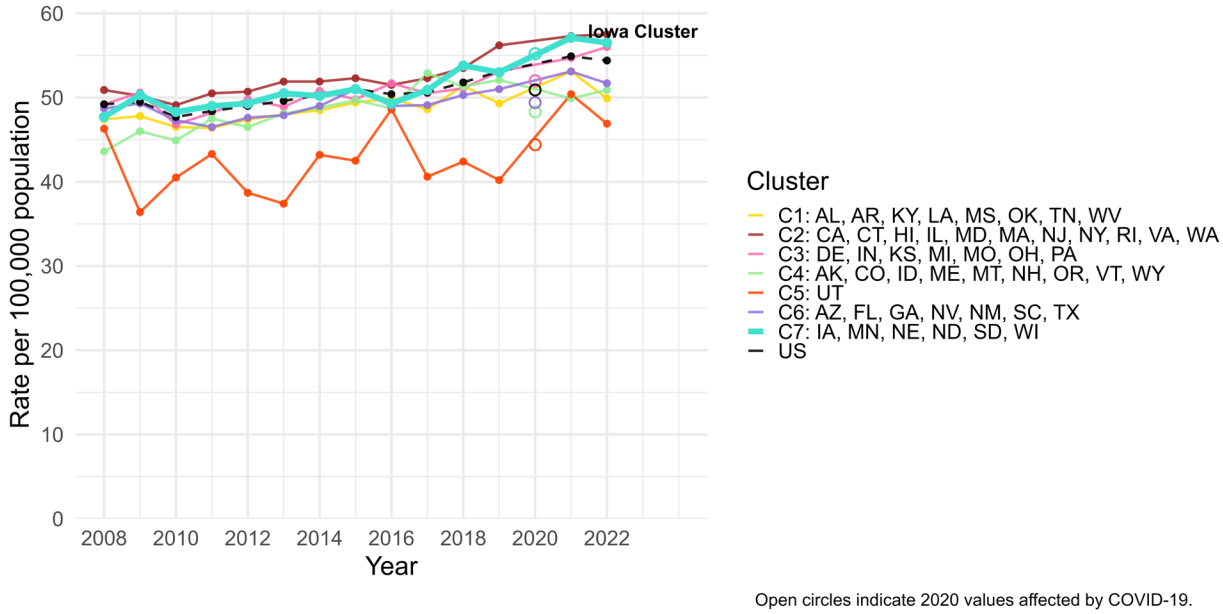
Figure 24. **Prostate cancer, ages 20+**: Age-adjusted incidence rates by state cluster



Data Source: CDC WONDER

For prostate cancer, Iowa's cluster generally followed national trends and trends of other clusters until 2014 when it began to increase more rapidly (**Figure 24**). In 2022, it had the second highest rate of prostate cancer behind only Utah, which is in a cluster by itself.

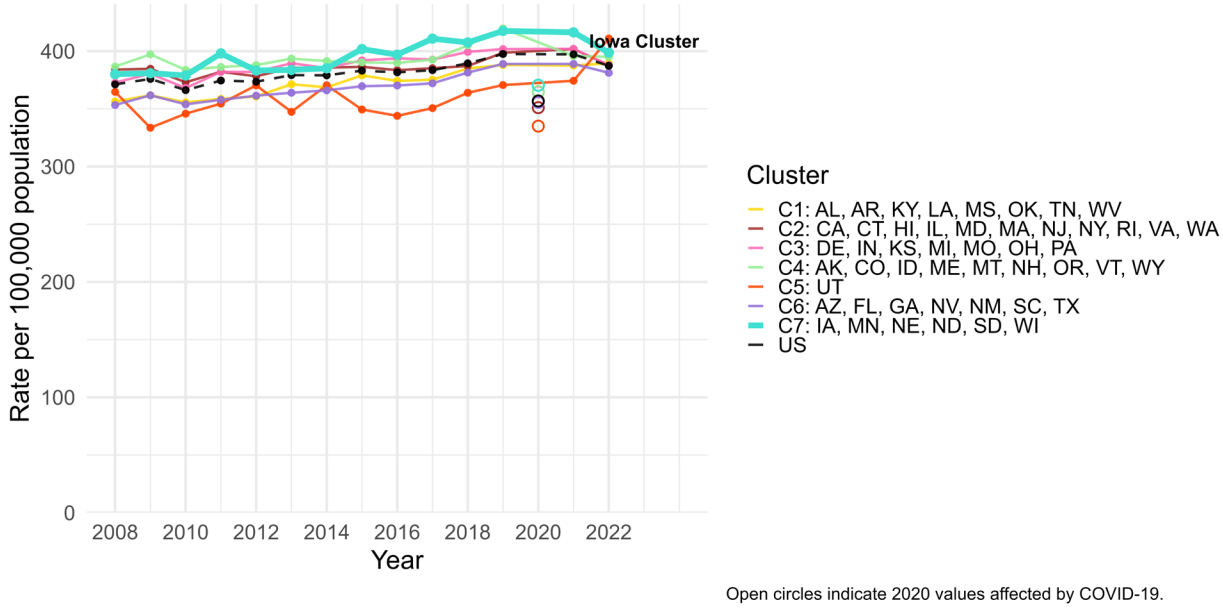
Figure 25. **Premenopausal breast cancer, ages 20–44**: Age-adjusted incidence rates by state cluster



Data Source: CDC WONDER

Iowa's cluster showed consistent increases in incidence rates of premenopausal breast cancer over time (**Figure 25**). It became higher than the U.S. rate in 2019 and remained elevated through 2022. Cluster 2 followed a similar trend.

Figure 26. **Postmenopausal breast cancer, ages 55+**: Age-adjusted incidence rates by state cluster

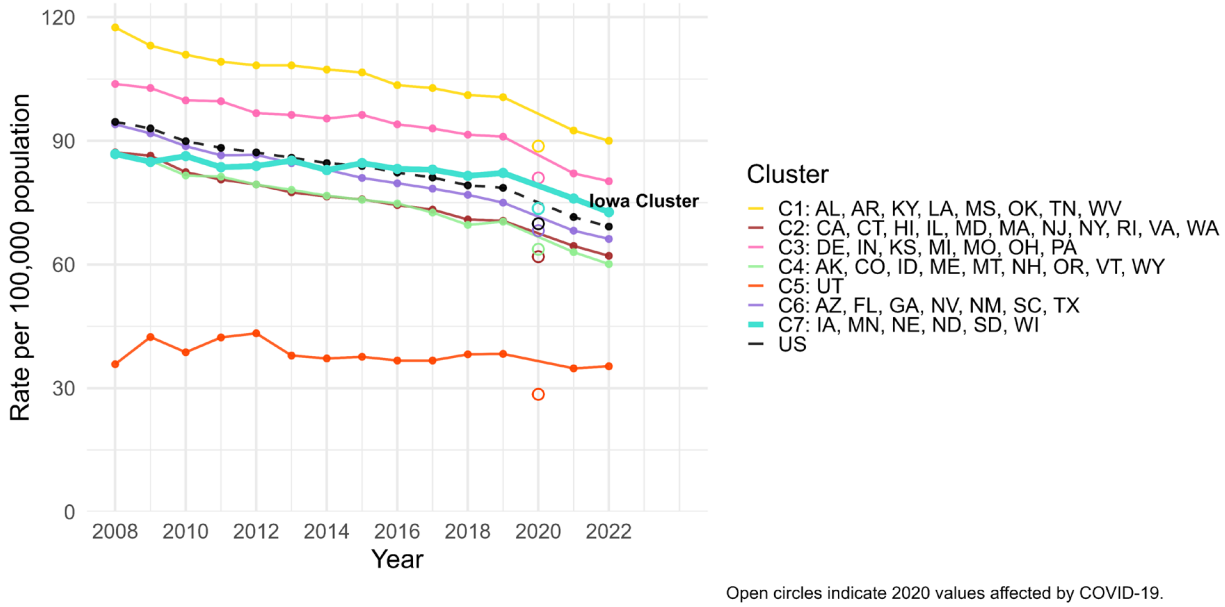


Open circles indicate 2020 values affected by COVID-19.

Data Source: CDC WONDER

Iowa's cluster showed consistently higher rates of postmenopausal breast cancer incidence compared to other clusters, which then began to rise more rapidly beginning in 2014 (**Figure 26**). Iowa's cluster had a decrease in incidence from 2021–2022, while Utah's rates increased to the highest rate of all clusters in 2022.

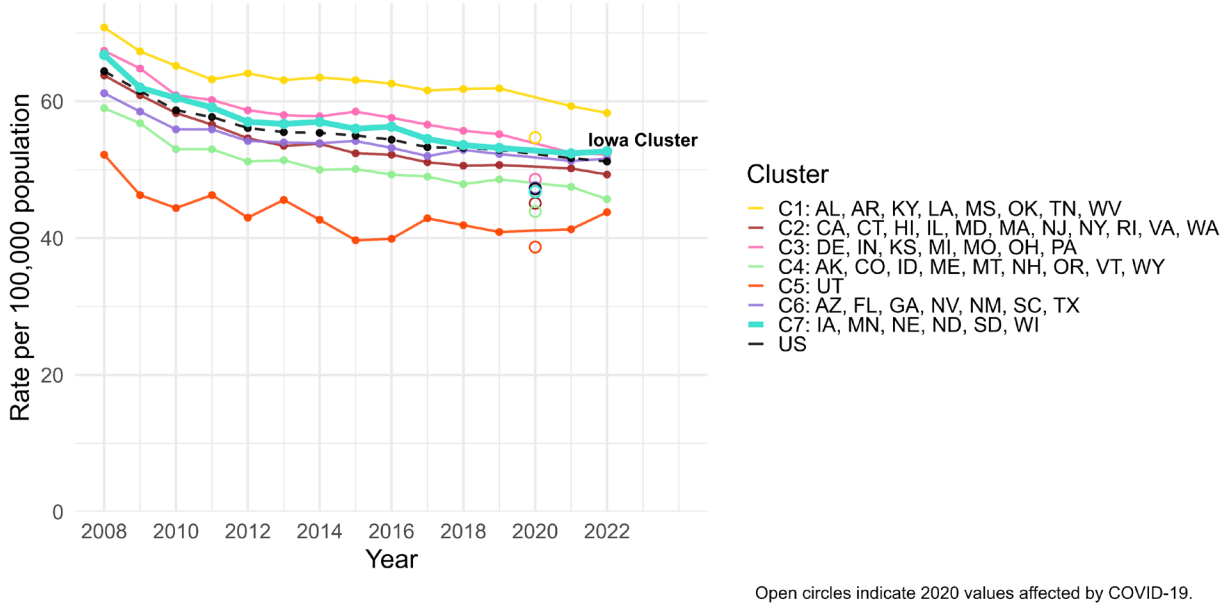
Figure 27. **Lung cancer, ages 20+**: Age-adjusted incidence rates by state clusters



Data Source: CDC WONDER

Iowa's cluster had the third highest rate of lung cancer, rising above the U.S. rate starting in 2015 (**Figure 27**). The rate of lung cancer has not been decreasing as quickly for the Iowa cluster compared to the other state clusters.

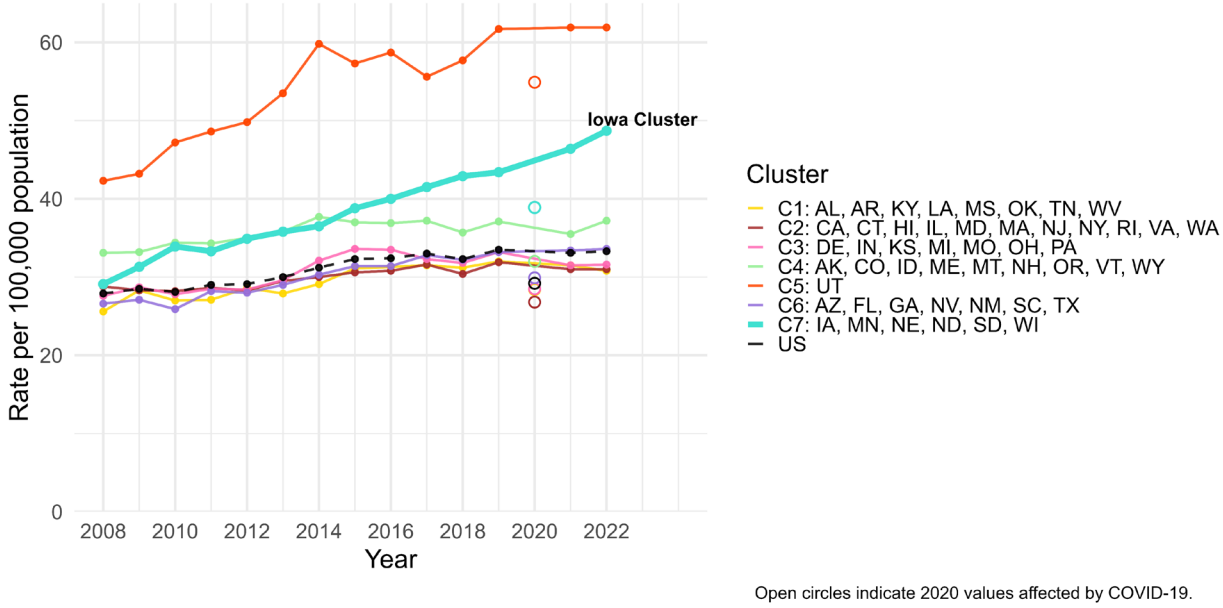
Figure 28. **Colorectal cancer, ages 20+**: Age-adjusted incidence rates by state clusters



Data Source: CDC WONDER

For colorectal cancer, Iowa's cluster was consistently the third highest of the state clusters and generally similar to the overall U.S. trend (**Figure 28**). In 2021 and 2022, Iowa's cluster increased to being the second highest in colorectal cancer rates.

Figure 29. **Melanoma, ages 20+**: Age-adjusted incidence rates by state clusters



Data Source: CDC WONDER

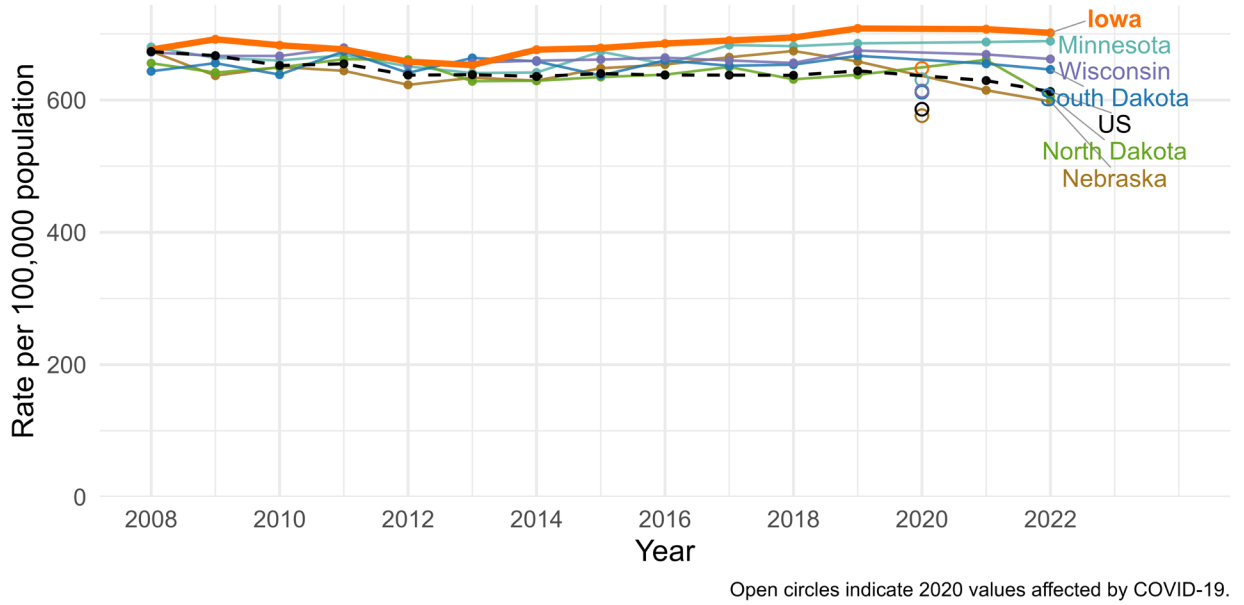
Iowa's cluster has had the second highest incidence rates of melanoma since 2015 and has been higher than the U.S. trend for the entire time period (**Figure 29**). Utah is the only other cluster that was higher than Iowa's cluster.

Summary: Residents in states that cluster with Iowa (Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin) have similar demographic characteristics and self-reported cancer-related behavioral risk behaviors, and the cluster had the highest cancer rate of all clusters**. Figures 23–29** demonstrated that age-adjusted cancer rates for Iowa's cluster are consistently higher than the national average for each cancer site that was examined.

The next step was to determine how Iowa compares to the other states within its cluster with similar behavioral risk factors and demographic characteristics in terms of cancer incidence and mortality trends. The results are presented in the following figures.

Cancer Incidence Trends for States in Iowa's Cluster

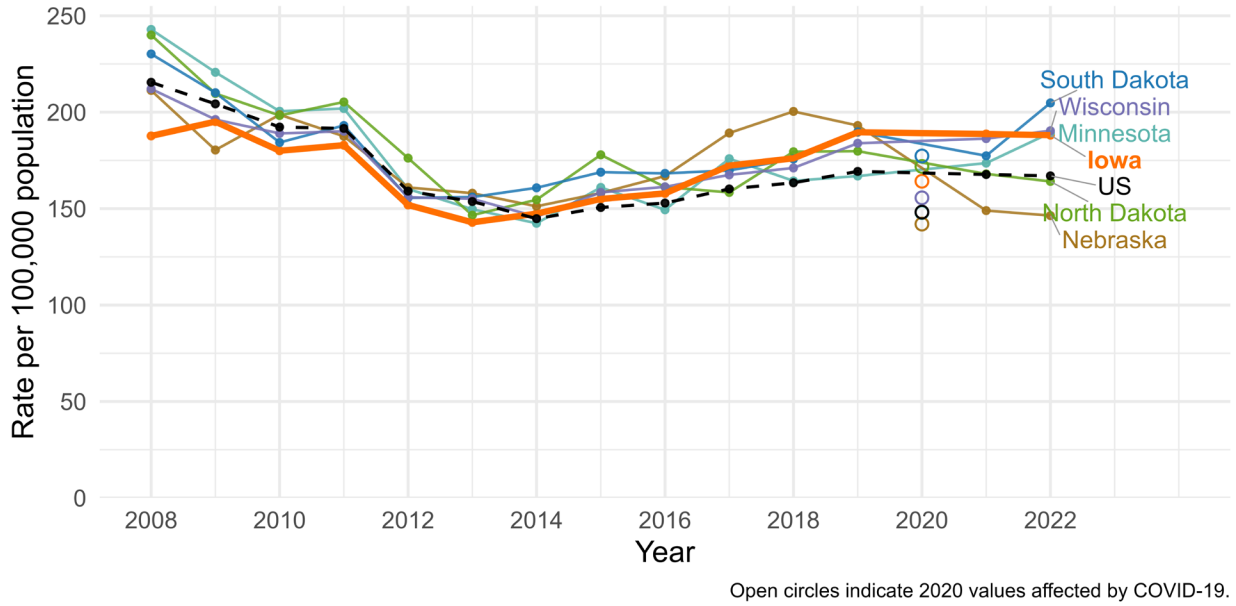
Figure 30. **All cancer sites, ages 20+**: Age-adjusted incidence rates for states in Iowa's cluster



Data Source: CDC WONDER

Figure 30 depicts trends for all cancer sites combined for each state within Iowa's cluster. Iowa's cancer trend began to rise above the other states in the cluster in 2014 and has continued to have the highest rate through 2022. Minnesota followed a similar trend; however, the other states in the cluster began decreasing similar to the national trend around 2018.

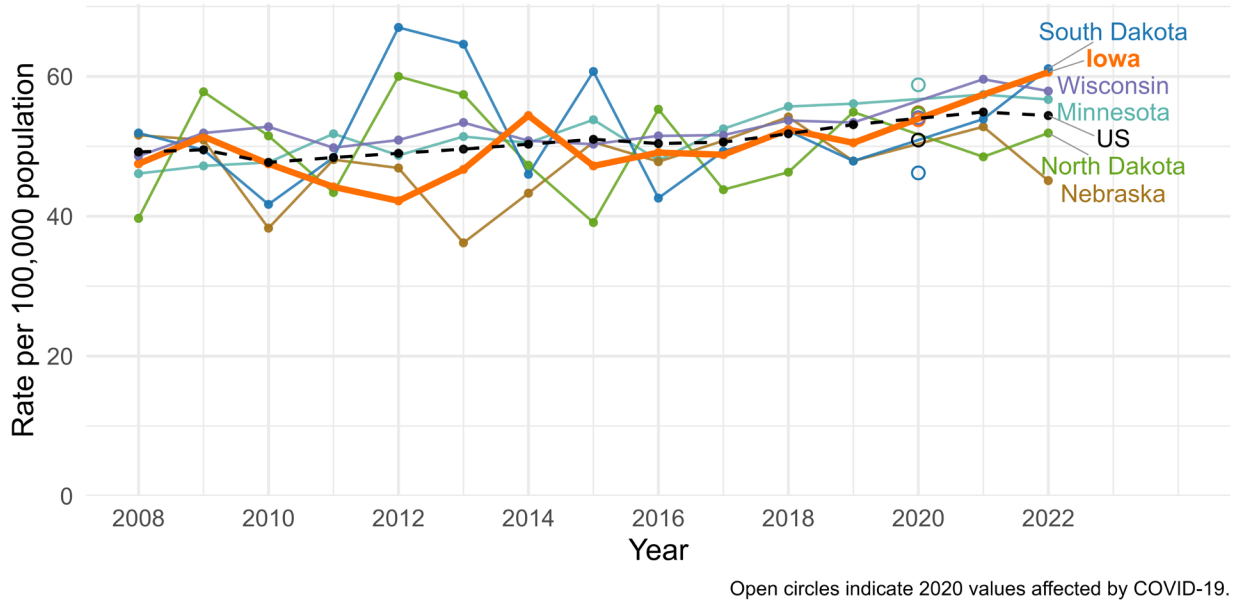
Figure 31. **Prostate cancer, Ages 20+:** Age-adjusted incidence rates for states in Iowa's cluster



Data Source: CDC WONDER

Iowa's rate of prostate cancer was the lowest in the cluster in 2008, and its trend was generally similar to the other states until 2014 when it began increasing at a faster rate (**Figure 31**). Iowa's rate began to level off in 2019 and was the 3rd highest in the cluster as of 2022.

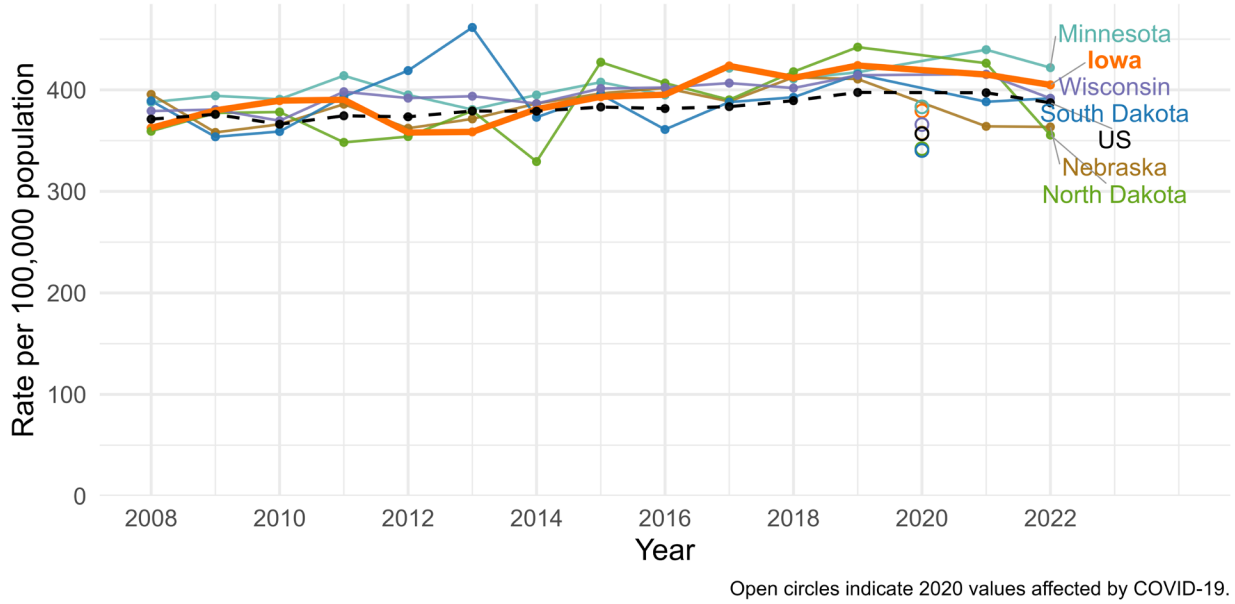
Figure 32. **Premenopausal breast cancer, ages 20–44**: Age-adjusted incidence rates for states in Iowa's cluster



Data Source: CDC WONDER

For premenopausal breast cancer, there was considerable variability across states in Iowa's cluster and rates were somewhat unstable due to relatively small numbers of cases (**Figure 32**). Iowa generally followed a pattern similar to the other states and the U.S. national rate over this time period but had the 2nd highest rates in the cluster by 2022.

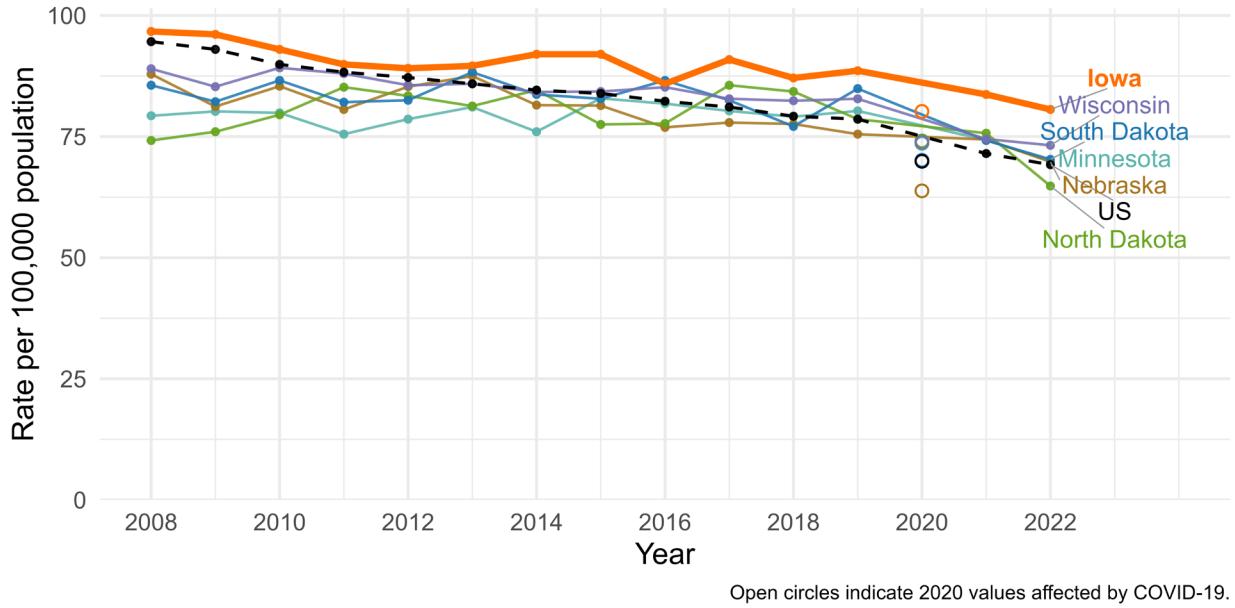
Figure 33. **Postmenopausal breast cancer, ages 55+**: Age-adjusted incidence rates for states in Iowa's cluster



Data Source: CDC WONDER

For postmenopausal breast cancer, Iowa's incidence rate began to rise more rapidly than the U.S. in 2013 (**Figure 33**). It began to level off in 2019 and was the second highest in the cluster after Minnesota in 2022.

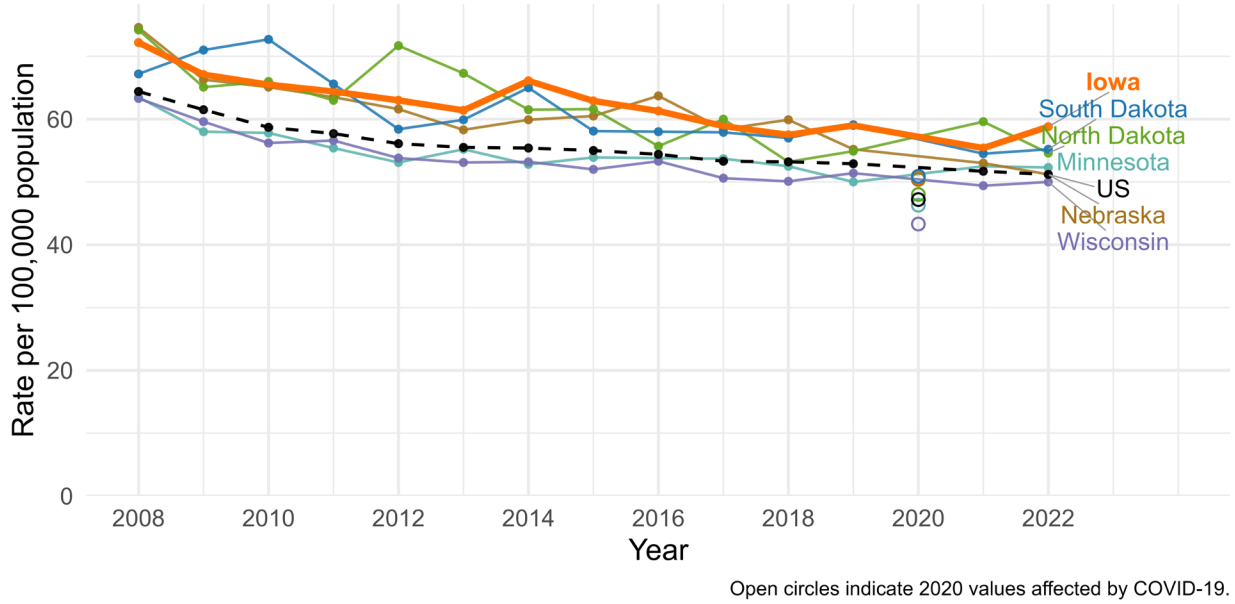
Figure 34. **Lung cancer, ages 20+**: Age-adjusted incidence rates for states in Iowa's cluster



Data Source: CDC WONDER

Prior to 2013, Iowa's age-adjusted lung cancer incidence rates were generally similar to the U.S. national trend, while other states in their cluster were below the national rates (**Figure 34**). After 2013, lung cancer incidence rates in the other states within the cluster declined more similarly to the national trend, whereas Iowa's rate remained elevated and the highest in the cluster through 2022.

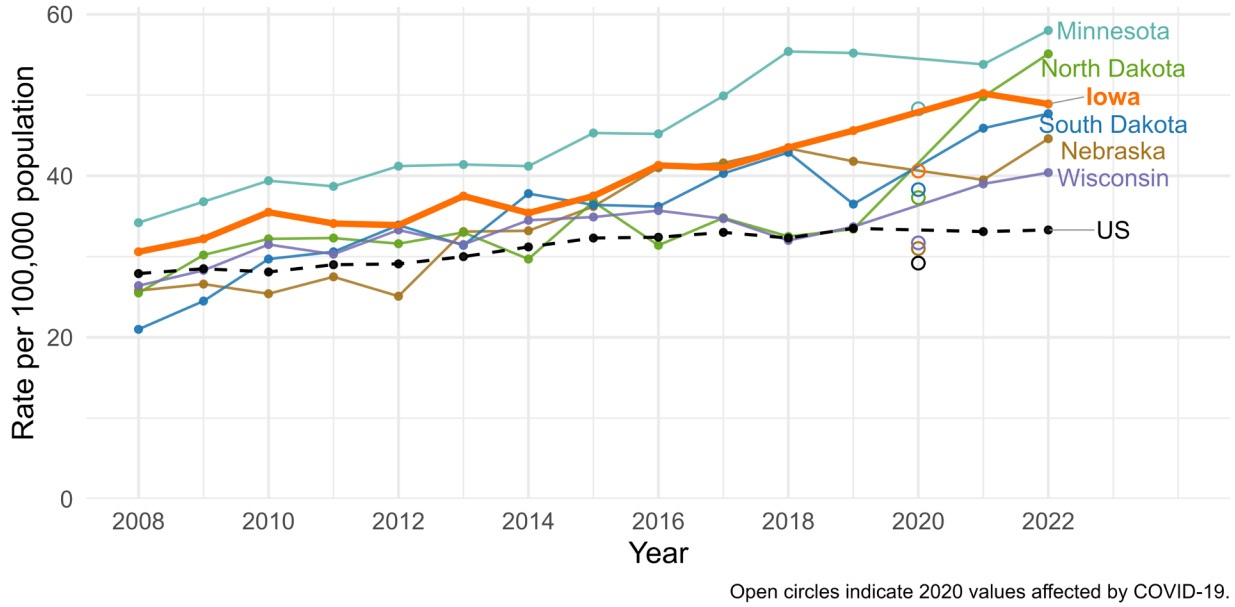
Figure 35. **Colorectal cancer, ages 20+**: Age-adjusted incidence rates for states in Iowa's cluster



Data Source: CDC WONDER

While Iowa's colorectal cancer incidence rate has been declining similarly to the other states within the cluster and the U.S. from 2008 through 2021, it has remained one of the highest rates throughout the time period (**Figure 35**). Iowa's rate increased from 2021 to 2022 to have the highest rate in its cluster.

Figure 36. **Melanoma, ages 20+**: Age-adjusted incidence rates for states in Iowa's cluster



Data Source: CDC WONDER

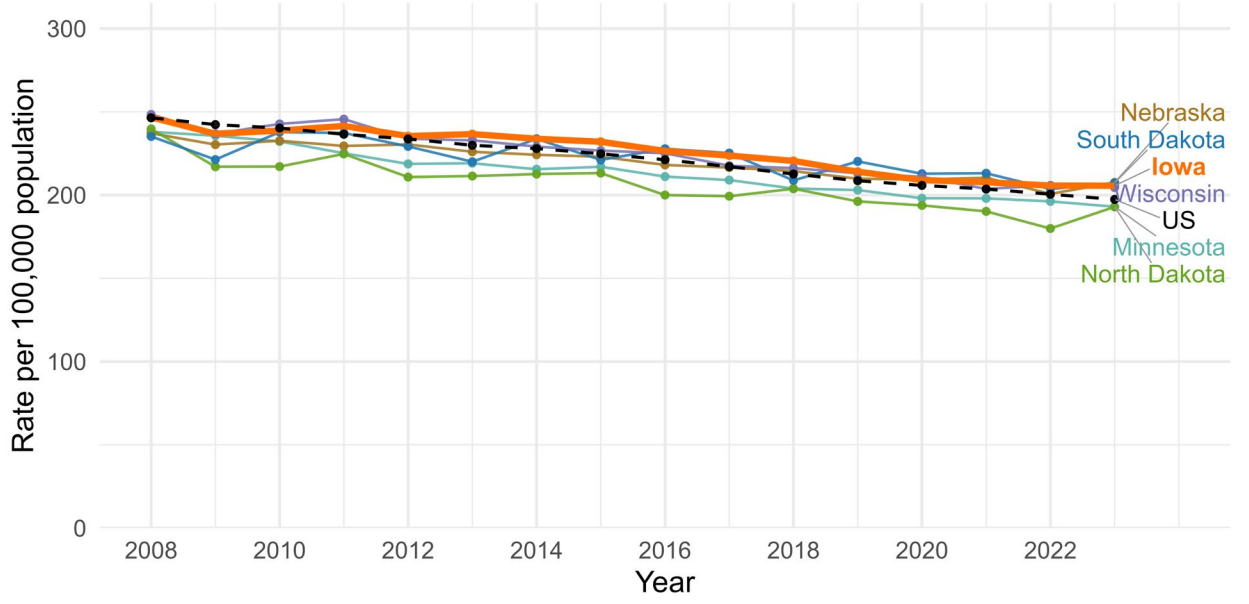
Age-adjusted melanoma incidence rates were generally higher than the U.S. national trend across most states in Iowa's cluster (**Figure 36**). Minnesota and Iowa ranked first and second, respectively, until 2021 when North Dakota surpassed Iowa. Iowa had the third highest rate in 2022.

Summary: Figures 30–36 demonstrated that compared to states within the Iowa cluster, Iowa had among the highest rates of the most common cancers, though its trends were generally consistent with those of other states in the cluster.

Cancer Mortality Trends for States in Iowa's Cluster

Figures 37–42 illustrate how Iowa's cancer mortality rates compare to the other states within its cluster (MN, NE, ND, SD, WI) with similar behavioral risk factors and demographic characteristics. Data shown for 2008–2023.

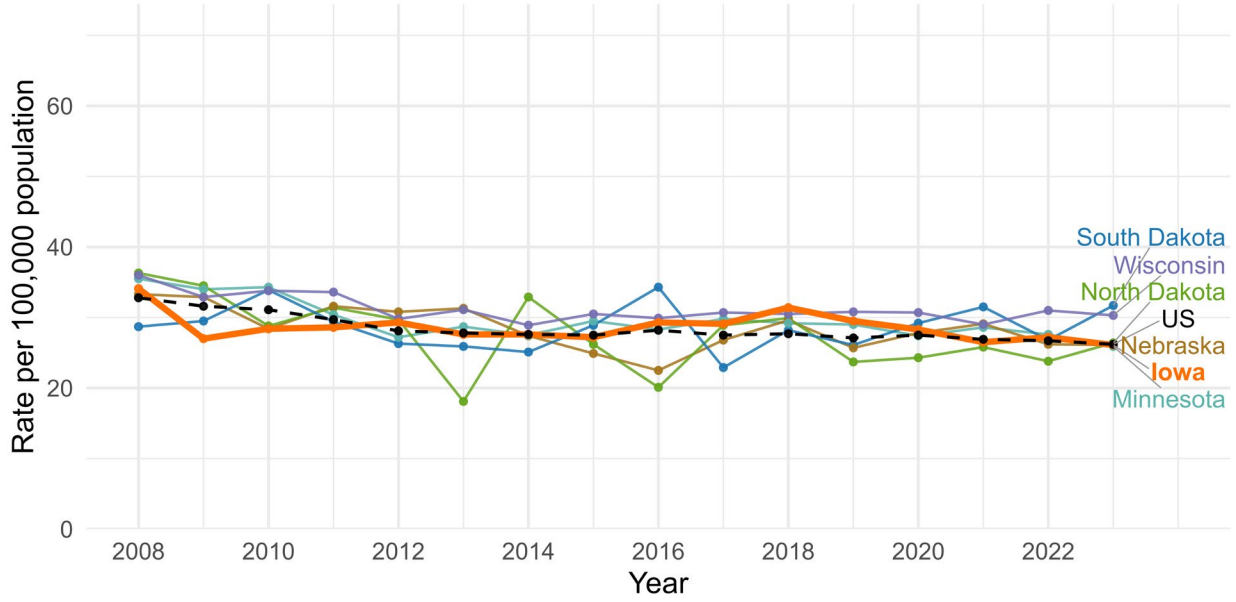
Figure 37. **All cancer sites, ages 20+**: Age-adjusted mortality rates for states in Iowa's cluster



*Data Source: SEER*Stat*

From 2008 to 2023, age-adjusted mortality rates for all cancer sites combined across the states in Iowa's cluster are very similar and closely follow the U.S. national trend (**Figure 37**). Iowa's mortality rate has been slightly above the U.S. rate since 2011.

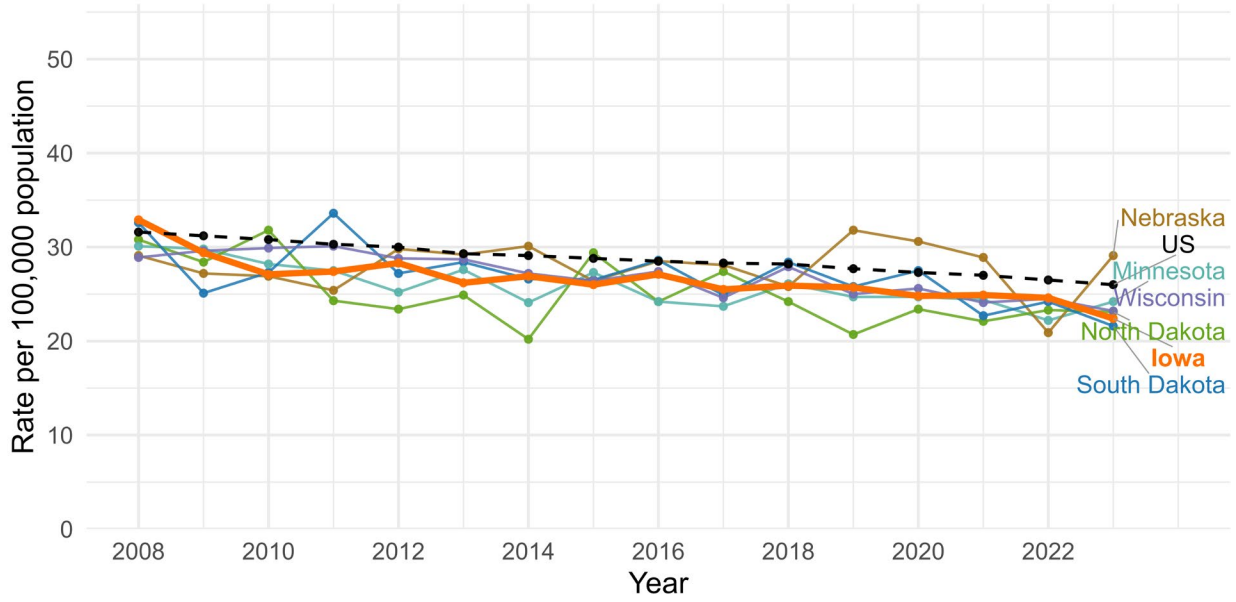
Figure 38. **Prostate cancer, ages 20+**: Age-adjusted mortality rates for states in Iowa's cluster



*Data Source: SEER*Stat*

Age-adjusted mortality rates for prostate cancer across the states in Iowa's cluster closely followed the U.S. national trend from 2008 to 2023 (**Figure 38**).

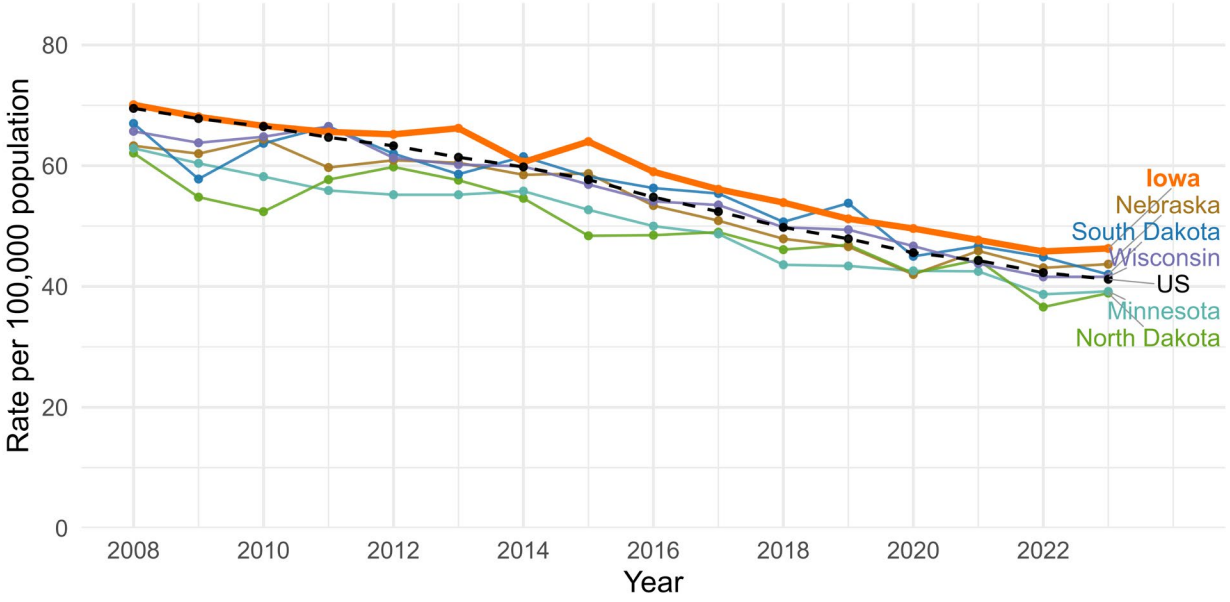
Figure 39. **Female breast cancer, ages 20+**: Age-adjusted mortality rates for states in Iowa's cluster



*Data Source: SEER*Stat*

Iowa's female breast cancer mortality rate is declining and has been consistently lower than the U.S. while similar to the other states in the cluster (**Figure 39**).

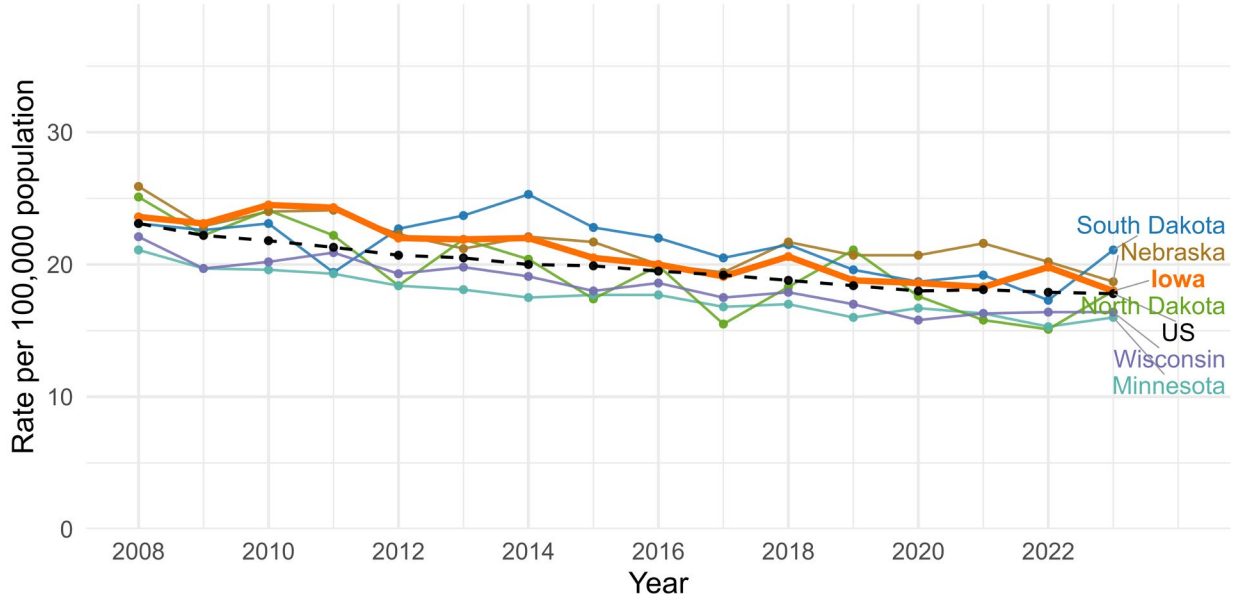
Figure 40. **Lung cancer, ages 20+**: Age-adjusted mortality rates for states in Iowa's cluster



*Data Source: SEER*Stat*

Iowa's lung cancer mortality rate has been consistently higher than the U.S. and other states within the cluster from 2011 through 2023 (**Figure 40**). The rates of most states within the cluster generally declined until 2022 when they started to level off or increase, unlike the U.S. rate which continued to decline through 2023. Iowa had the highest lung cancer mortality rate in the cluster in 2023.

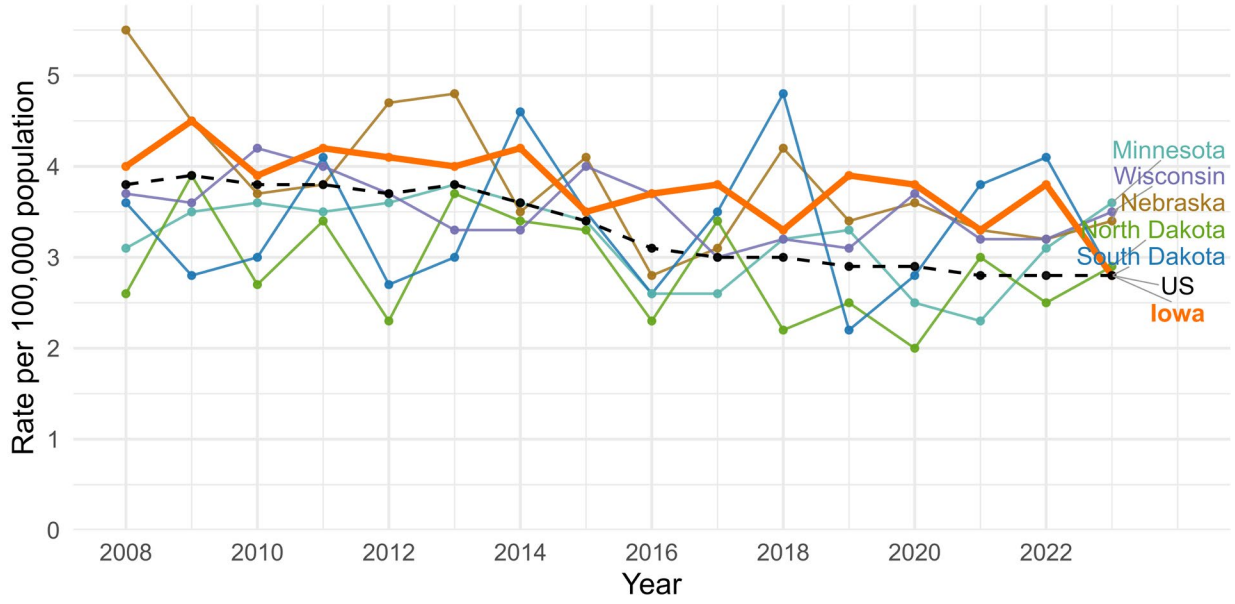
Figure 41. **Colorectal cancer, ages 20+**: Age-adjusted mortality rates for states in Iowa's cluster



*Data Source: SEER*Stat*

Overall, mortality rates for colorectal cancer across the cluster closely followed the U.S. national trend (**Figure 41**).

Figure 42. **Melanoma, ages 20+**: Age-adjusted mortality rates for states in Iowa's cluster



*Data Source: SEER*Stat*

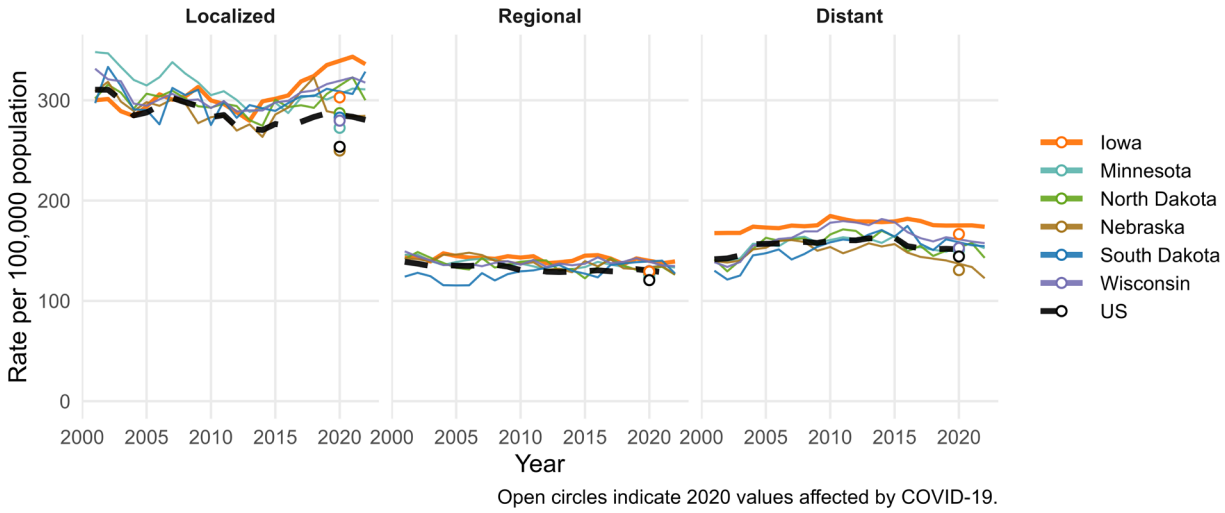
Overall, melanoma mortality rates across the cluster generally followed the U.S. national trend from 2008 to 2023 (**Figure 42**). The apparent variability in the plots is largely due to the lower mortality from melanoma relative to other cancers (between 2–5 deaths from melanoma per 100,000 population). Iowa's melanoma mortality rate was consistently higher than the U.S. rate until 2023 when it decreased to the level of the U.S.

Summary: Iowa's age-adjusted mortality rates are generally similar to other states in the cluster except for lung cancer, which is substantially higher in Iowa.

Cancer Incidence Trends by Stage for States in Iowa's Cluster

Figures 43–48 illustrate how Iowa's cancer incidence rates by stage at diagnosis compare to the other states within its cluster (MN, NE, ND, SD, WI) with similar behavioral risk factors and demographic characteristics. Stage at diagnosis is classified as localized (early stage, confined to the primary site), regional (spread to nearby lymph nodes or tissues) or distant (metastatic, spread to distant organs). Data shown for 2001–2022.

Figure 43. **All cancer sites, ages 20+**: Age-adjusted incidence rates by stage for states in Iowa's cluster

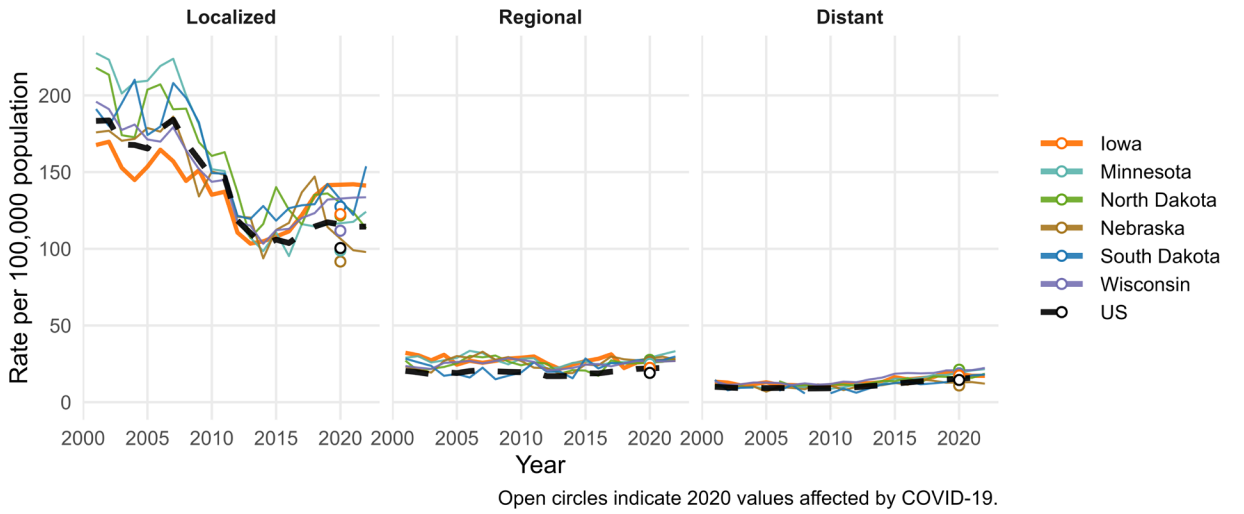


*Data Source: SEER*Stat*

Across all cancer sites by stage, localized (early stage) incidence rates among states in Iowa's cluster were generally higher than U.S. national rates, with Iowa having the highest early-stage incidence among the states (**Figure 43**).

For regional (spread to nearby lymph nodes or tissues) and distant (metastatic) stage cancer, incidence rates generally followed the U.S. national trend and were similar across most states in their cluster; however, Iowa had consistently higher distant stage incidence rates compared to the other states.

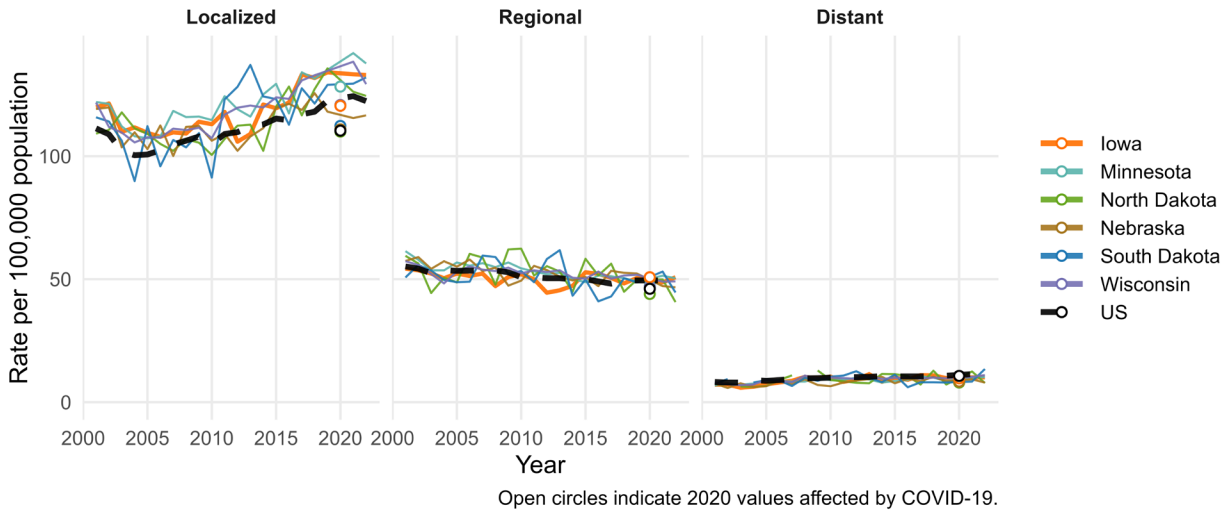
Figure 44. **Prostate cancer, ages 20+**: Age-adjusted incidence rates by stage for states in Iowa's cluster



*Data Source: SEER*Stat*

For states in Iowa's cluster, prostate cancer incidence rates for regional and distant stage generally followed the U.S. national trends (**Figure 44**). In contrast, while localized prostate cancer incidence rates in most states in the cluster followed the U.S. trend, their rates were higher than the U.S. rate, while Iowa's rate remained below the U.S. rate until 2014. It then began to rapidly increase, and surpassed the U.S. rate and the rates of most other states in the cluster.

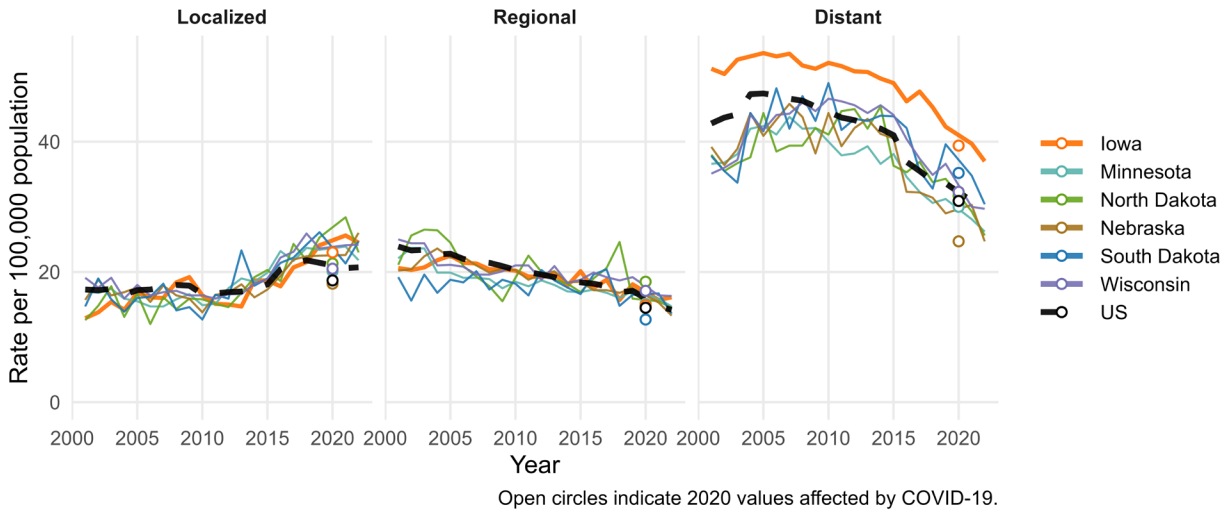
Figure 45. **Female breast cancer, ages 20+**: Age-adjusted incidence rates by stage for states in Iowa's cluster



*Data Source: SEER*Stat*

Iowa's incidence rate of localized female breast cancer has been increasing over time, and has been consistently higher than the U.S. and most other states within the cluster with the exception of 2012–2013 (**Figure 45**). Regional incidence rates have generally declined similarly across states in Iowa's cluster and the U.S., while distant stage incidence has remained low and relatively stable over time for all states within the cluster and the U.S.

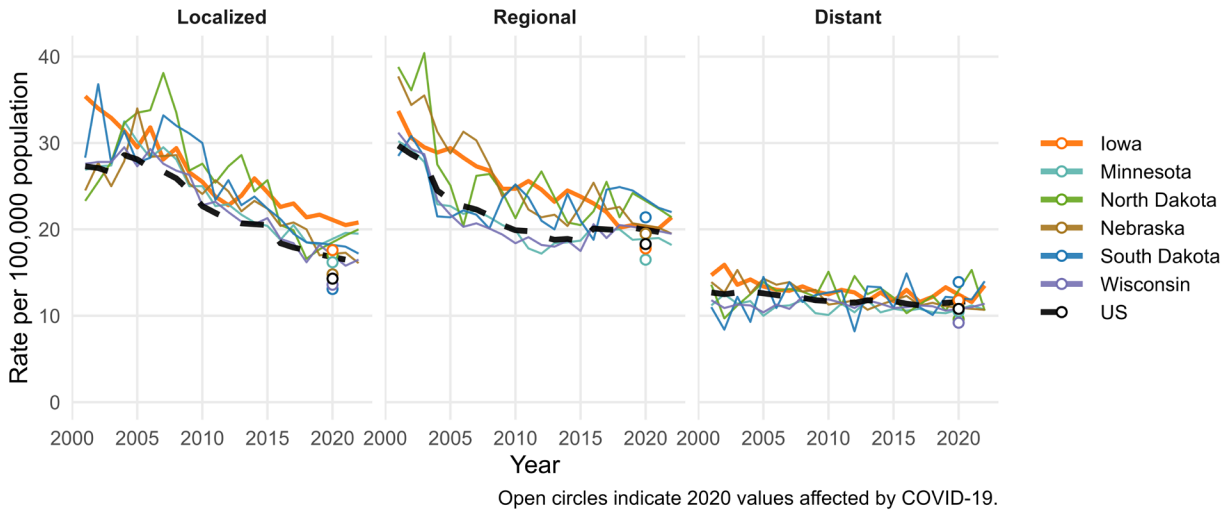
Figure 46. **Lung cancer, ages 20+**: Age-adjusted incidence rates by stage for states in Iowa's cluster



*Data Source: SEER*Stat*

When examined by stage at diagnosis, localized and regional lung cancer incidence rates in Iowa closely follow the U.S. national trends and other states in the cluster (**Figure 46**). In contrast, Iowa shows consistently higher distant stage (metastatic) incidence rates across time, though the direction of the overall trend follows the national pattern. The distant stage lung cancer rates for other states in the cluster were below the national trend prior to 2013 and then moved closer to the national trend in later years.

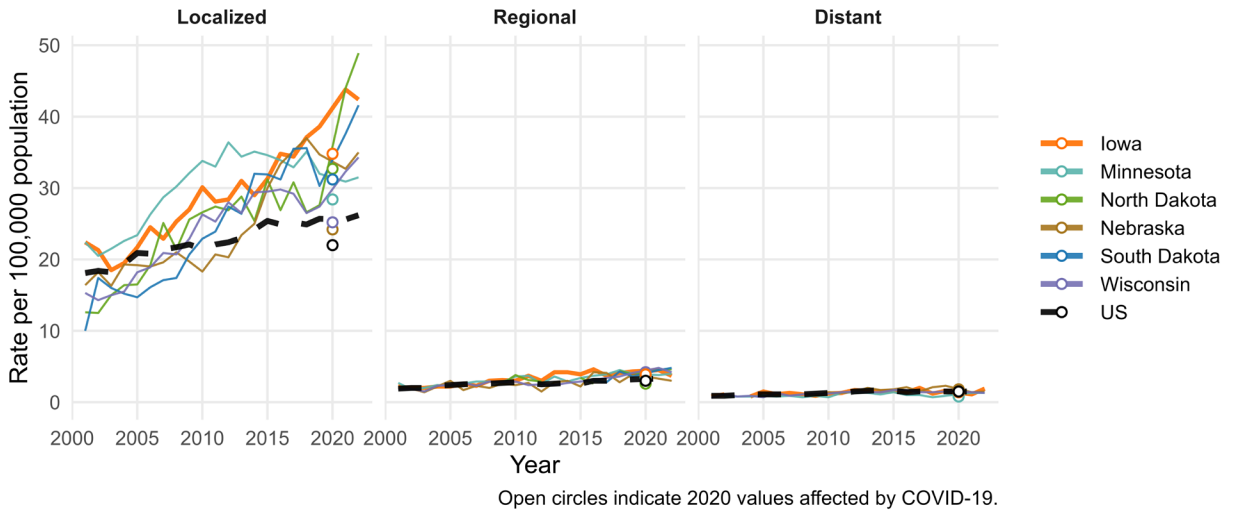
Figure 47. **Colorectal cancer, ages 20+**: Age-adjusted incidence rates by stage for states in Iowa's cluster



*Data Source: SEER*Stat*

Colorectal cancer incidence rates declined over time for each stage at diagnosis in Iowa, the states in its cluster, and the U.S. (**Figure 47**). However, Iowa has had a consistently higher rate across stages over time compared to the U.S. and has had the highest rate of localized stage colorectal cancer from 2015 to 2022 compared to other states in the cluster.

Figure 48. **Melanoma cancer, ages 20+**: Age-adjusted incidence rates by stage for states in Iowa's cluster



*Data Source: SEER*Stat*

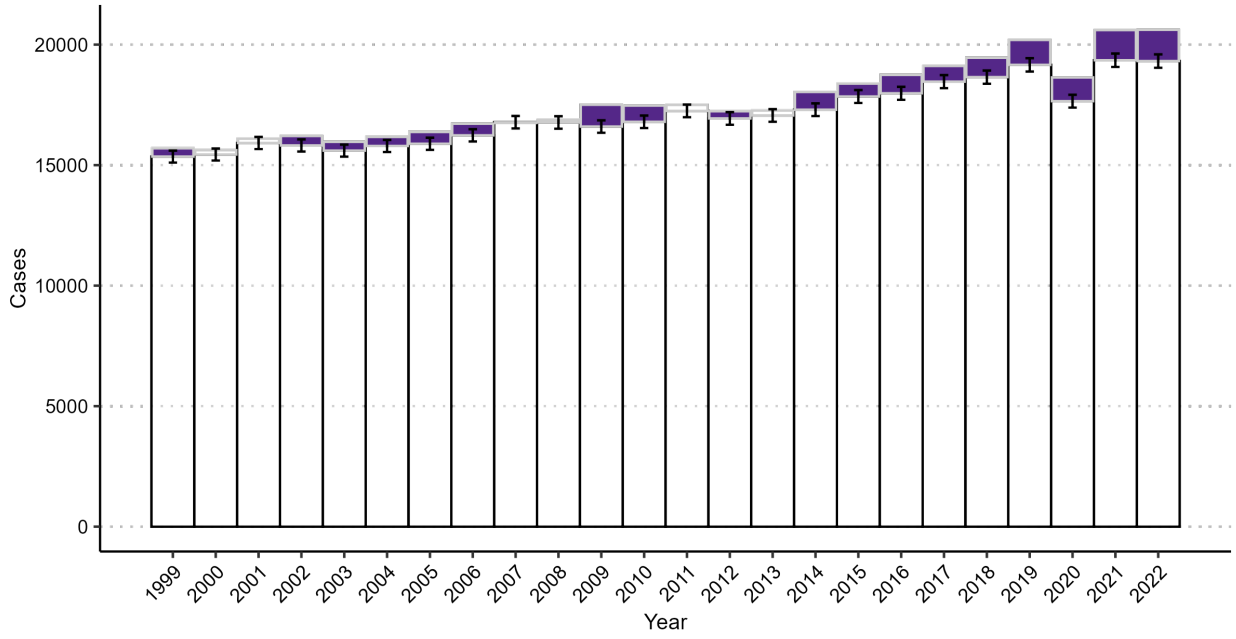
Iowa's localized melanoma incidence rate followed a similarly increasing trend as states in its cluster early in the time period but increased more sharply beginning in 2018 (**Figure 48**). The localized rates in all states in the cluster have risen higher than the U.S. trend. Regional and distant stage melanoma rates have been similar for all the states in its cluster and similar to U.S. trends, though most states in the cluster had higher rates of regional stage melanoma compared to the U.S. in 2022.

Summary: Iowa had a higher overall age-adjusted rate of early stage (localized) incidence across most cancers compared to the other states in the cluster but also had a higher age-adjusted rate of distant (metastatic) lung cancer.

Estimated Excess Cases Relative to Iowa's Cluster by Site over Time

In earlier analyses, excess cases were defined relative to the U.S. national trend. Here, we shift the comparison to a regional cluster of states with similar demographic composition and risk factor profiles (MN, NE, ND, SD, and WI). This approach reframes excess burden as the number of cancer cases observed in Iowa beyond expected if Iowa experienced incidence patterns comparable to the states in their cluster overall. From these analyses we aim to learn if Iowa's rates are outside the normative range relative to the states in the same cluster that have similar behavioral risk factors and demographic characteristics.

Figure 49. **All cancer sites, ages 20+**: Iowa observed, expected, and excess cases relative to Iowa's cluster



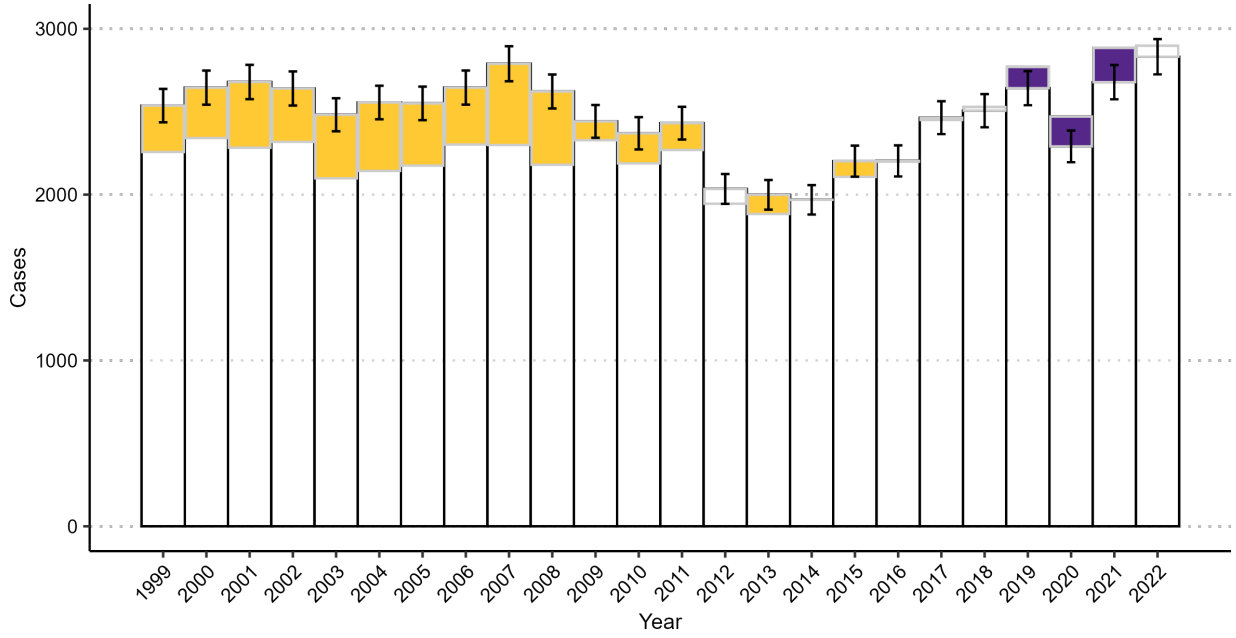
Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	15697	15619	16098	16209	15965	16170	16375	16717	16749	16875	17505	17470	17498	17235	17265	18036	18382	18744	19115	19454	20194	18637	20603	20615
Expected	15354	15439	15917	15816	15601	15793	15885	16234	16780	16769	16600	16797	17249	16938	17060	17298	17846	17980	18463	18651	19160	17653	19351	19317
Excess	343	180	181	393	364	377	490	483	-31	106	905	673	249	297	205	738	536	764	652	803	1034	984	1252	1298

Data Source: CDC WONDER

Across all cancer sites, Iowa still showed excess cases when compared to its cluster (**Figure 49**). Although estimated excess decreases from 2,582 cases based on comparisons to the entire U.S., to 1,298 excess cases when comparing only to the states in their cluster, the overall pattern over time remains similar. This reduction suggests that the states in Iowa's cluster have relatively higher cancer rates compared to other clusters, yet

Iowa continues to experience elevated excess cases even among this group of states with higher rates of cancer and similar behavioral risk factors and demographic characteristics.

Figure 50. **Prostate cancer, ages 20+**: Iowa observed, expected, and excess cases relative to Iowa's cluster

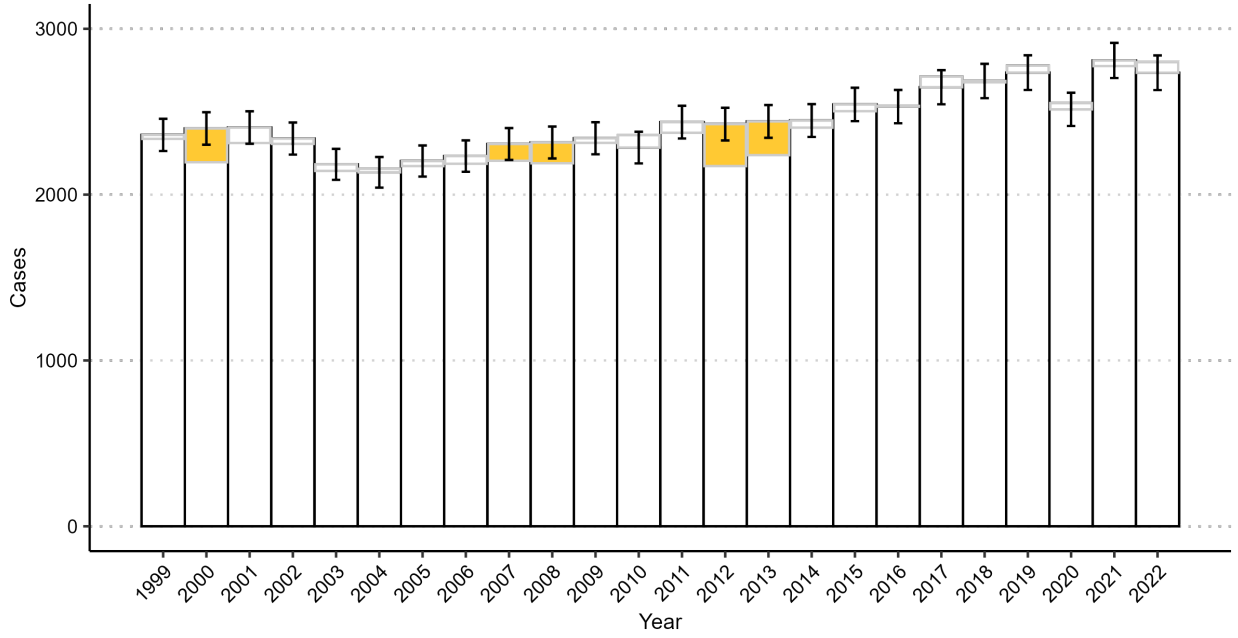


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	2257	2341	2283	2318	2098	2143	2175	2302	2299	2180	2328	2188	2269	1945	1883	1969	2107	2199	2450	2528	2770	2471	2885	2898
Expected	2537	2645	2679	2640	2482	2556	2550	2646	2789	2622	2442	2370	2431	2034	1999	1969	2202	2203	2464	2506	2642	2291	2678	2832
Excess	-280	-304	-396	-322	-384	-413	-375	-344	-490	-442	-114	-182	-162	-89	-116	0	-95	-4	-14	22	128	180	207	66

Data Source: CDC WONDER

For prostate cancer, the estimated excess number of cases in 2022 was 331 relative to the U.S. as a whole (**Figure 50**). When compared only to states in the Iowa cluster, the estimated excess decreases to 66 excess cases and falls within the expected range.

Figure 51. **Female breast cancer, ages 20+**: Iowa observed, expected, and excess cases relative to Iowa's cluster

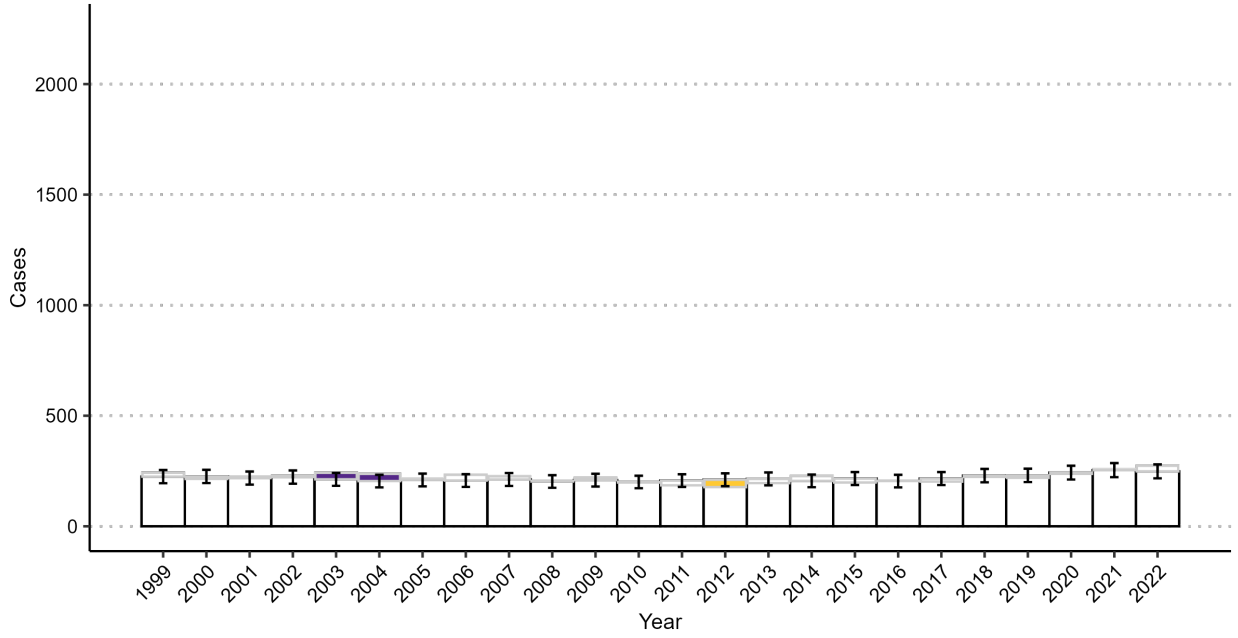


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	2336	2195	2311	2306	2143	2156	2172	2186	2204	2189	2312	2359	2373	2172	2238	2404	2503	2535	2712	2677	2778	2552	2775	2799
Expected	2360	2399	2405	2338	2183	2135	2203	2233	2305	2314	2340	2284	2437	2425	2442	2447	2544	2531	2648	2685	2736	2514	2809	2735
Excess	-24	-204	-94	-32	-40	21	-31	-47	-101	-125	-28	75	-64	-253	-204	-43	-41	4	64	-8	42	38	-34	64

Data Source: CDC WONDER

When previously compared to U.S. trends, Iowa had an estimated excess of 141 cases of female breast cancer in 2022 (**Figure 14**). Excess case counts exceeded the expected range from 2017 through 2022. However, **Figure 51** shows that when comparing Iowa to only the other states in Iowa's cluster, the estimated number of excess cases in 2022 decreases to 64 and excesses were within or below the expected range of cases for all years. This shows that Iowa's female breast cancer patterns are more similar to the states in their cluster than to the U.S. as a whole.

Figure 52. **Premenopausal breast cancer, ages 20–44**: Iowa observed, expected, and excess cases relative to Iowa's cluster

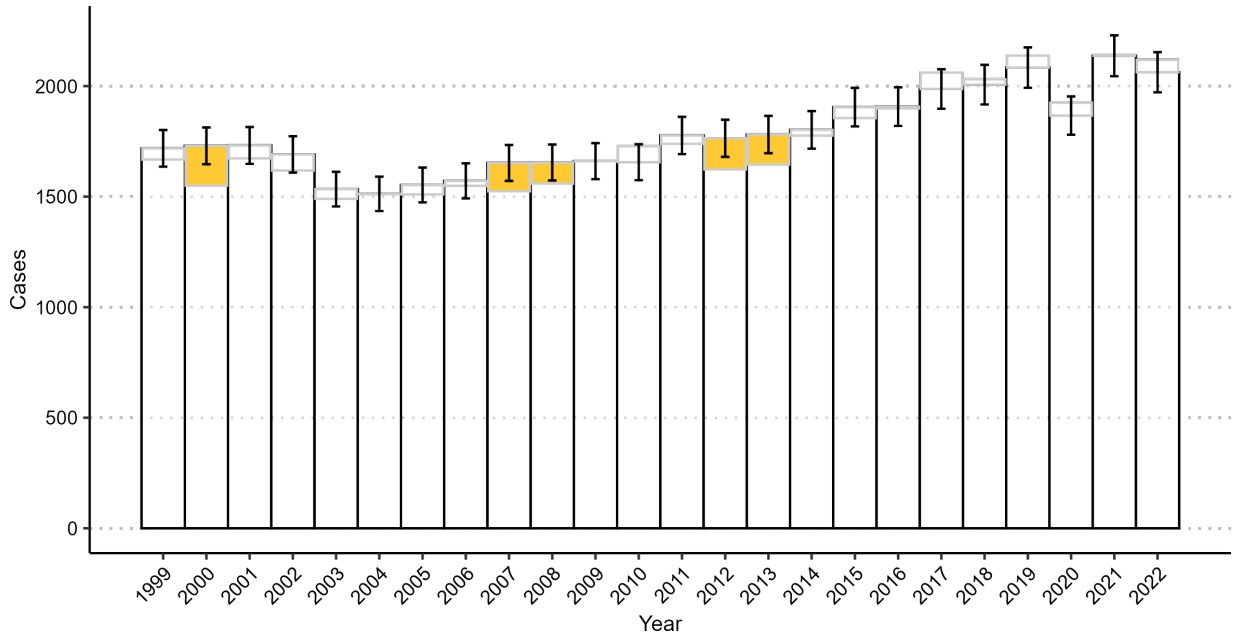


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	242	214	224	228	242	237	213	233	226	205	218	198	185	177	195	227	198	205	202	223	219	237	257	274
Expected	225	225	218	223	212	204	209	207	212	203	209	200	207	210	214	205	216	204	216	229	230	243	254	248
Excess	17	-11	6	5	30	33	4	26	14	2	9	-2	-22	-33	-19	22	-18	1	-14	-6	-11	-6	3	26

Data Source: CDC WONDER

When separating female breast cancer cases by menopausal status, premenopausal breast cancer shows relatively few excess cases in Iowa, both in prior comparisons to the U.S. national trend and in comparisons to their cluster of states (**Figure 52**).

Figure 53. **Postmenopausal breast cancer, ages 55+**: Iowa observed, expected, and excess cases relative to Iowa's cluster



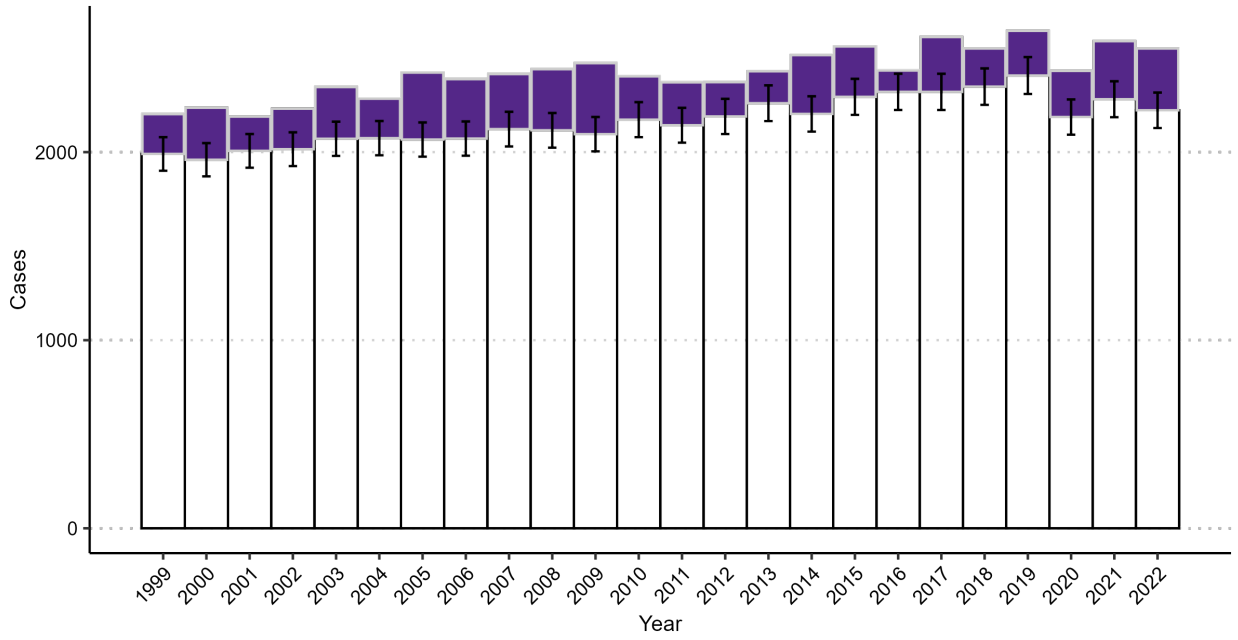
Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	1668	1550	1673	1618	1490	1511	1510	1549	1524	1559	1661	1728	1739	1623	1645	1776	1855	1899	2061	2031	2138	1925	2140	2119
Expected	1718	1730	1732	1691	1534	1513	1553	1571	1652	1654	1661	1656	1777	1764	1781	1802	1905	1907	1987	2006	2084	1867	2137	2063
Excess	-50	-180	-59	-73	-44	-2	-43	-22	-128	-95	0	72	-38	-141	-136	-26	-50	-8	74	25	54	58	3	56

Data Source: CDC WONDER

In Iowa, there were 107 excess cases of postmenopausal breast cancer relative to the U.S. national trend in 2022 (**Figure 16**). **Figure 53** shows that when compared to only states in the Iowa cluster, Iowa's estimated excess cases in 2022 were reduced to 56 cases.

Overall, breast cancer among women ages 20+ in Iowa is more consistent with patterns observed in its cluster states than with the U.S. national trend. This is also observed when separated by menopausal status. While some excess cases remain, the cluster comparison provides context showing that female breast cancer in Iowa is similar to the other states in its cluster.

Figure 54. **Lung cancer, ages 20+**: Iowa observed, expected, and excess cases relative to Iowa's cluster

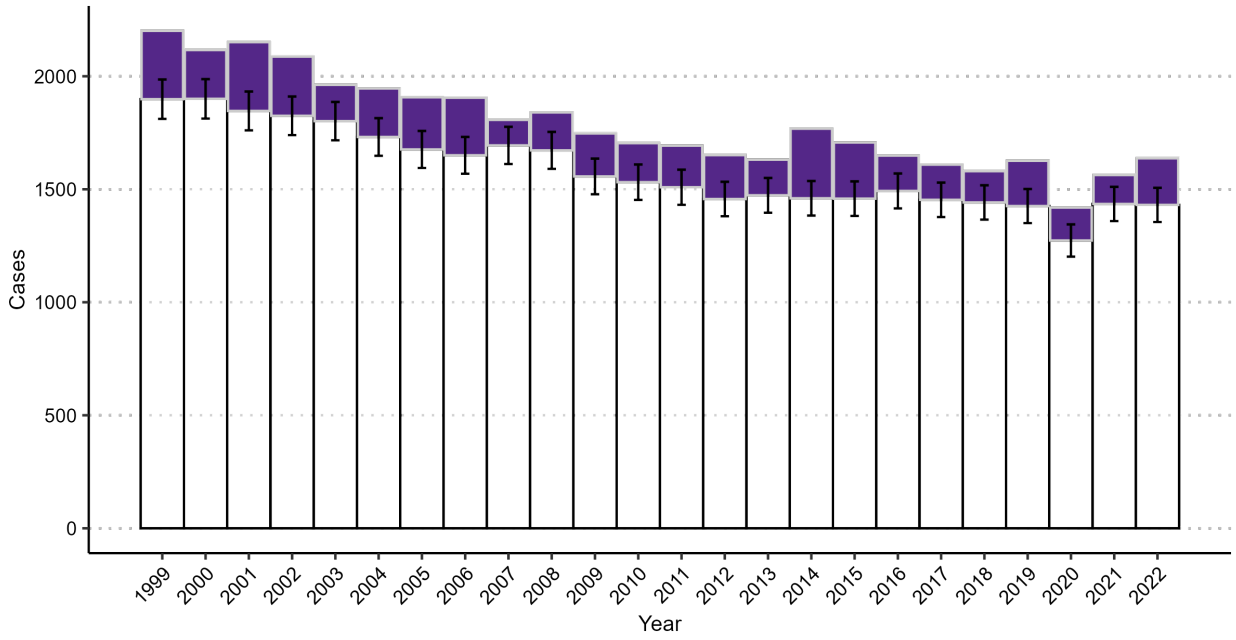


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	2202	2236	2189	2231	2346	2284	2423	2388	2415	2441	2473	2403	2371	2372	2430	2516	2562	2434	2612	2551	2645	2432	2590	2551
Expected	1990	1959	2007	2016	2071	2074	2067	2072	2122	2116	2095	2173	2143	2190	2260	2203	2294	2320	2320	2348	2407	2187	2281	2222
Excess	212	277	182	215	275	210	356	316	293	325	378	230	228	182	170	313	268	114	292	203	238	245	309	329

Data Source: CDC WONDER

Previously, Iowa had excess lung cancer cases above expected when compared with the U.S. national trend, primarily after 2013. In contrast, when compared with its cluster, Iowa's excess cases are consistently above the expected range across the entire time period. In 2022, there were 376 excess cases of lung cancer relative to the U.S. (**Figure 17**). When compared to only states in the Iowa cluster, Iowa's estimated number of excess lung cancer cases was still similarly elevated at 329 cases (**Figure 54**). In contrast to female breast and prostate cancers, the cluster comparison provides context showing that lung cancer in Iowa is **not comparable** to the other states in its cluster.

Figure 55. **Colorectal cancer, ages 20+**: Iowa observed, expected, and excess cases relative to Iowa's cluster

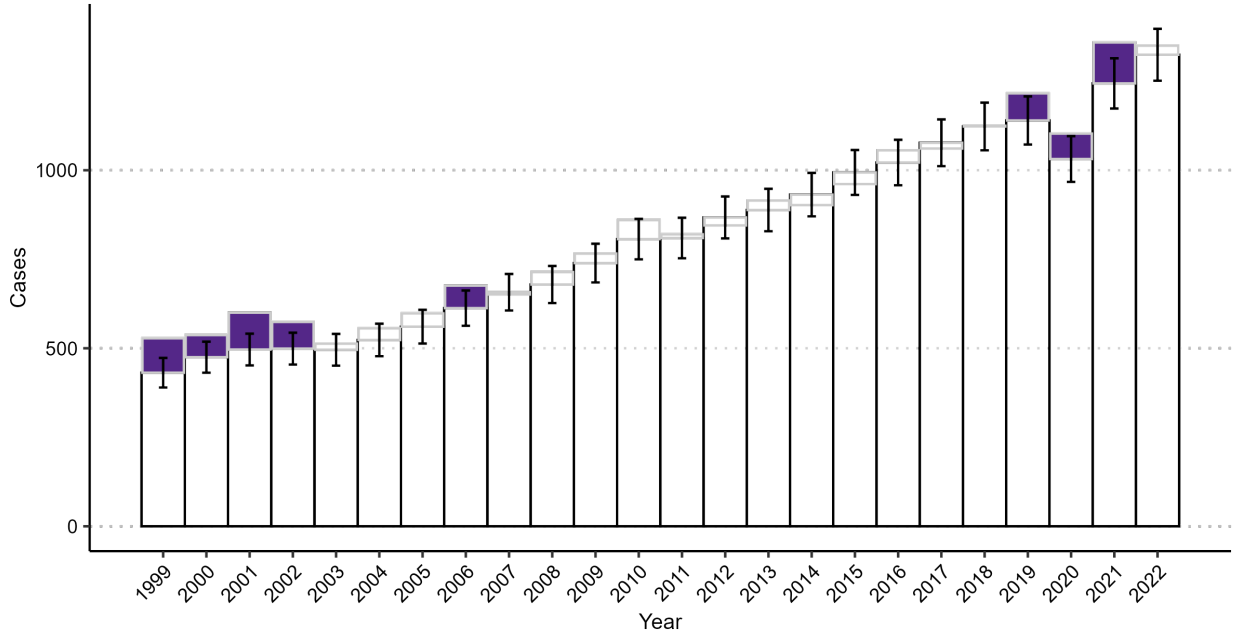


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	2201	2116	2151	2087	1962	1946	1907	1905	1807	1840	1747	1704	1693	1651	1631	1768	1707	1649	1609	1580	1626	1419	1563	1637
Expected	1899	1900	1847	1825	1801	1731	1676	1650	1694	1672	1557	1531	1509	1457	1473	1460	1458	1493	1453	1442	1426	1273	1435	1431
Excess	302	216	304	262	161	215	231	255	113	168	190	173	184	194	158	308	249	156	156	138	200	146	128	206

Data Source: CDC WONDER

While Iowa's incidence rate of colorectal cancer is declining at a rate similar to the U.S. and other states within its cluster, its rate is consistently higher than the U.S. national rate and the other states in the cluster. In 2022, there were 189 excess cases of colorectal cancer relative to the U.S. national trend (**Figure 18**). When compared to only states in the Iowa cluster, Iowa's estimated number of excess colorectal cases was still similarly elevated at 206 cases (**Figure 55**). The cluster comparison provides context showing that colorectal cancer in Iowa is **not comparable** to the other states in its cluster.

Figure 56. **Melanoma, ages 20+**: Iowa observed, expected, and excess cases relative to Iowa's cluster

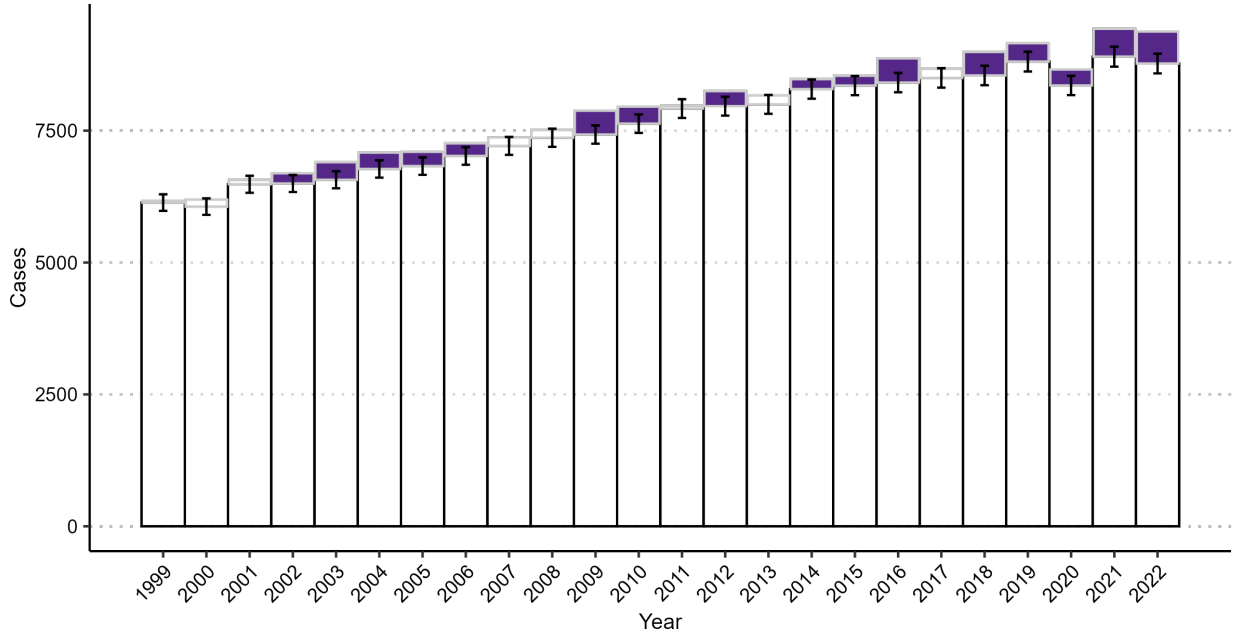


Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	528	537	600	574	513	556	598	676	651	714	766	860	820	845	915	902	961	1056	1061	1125	1216	1103	1359	1350
Expected	431	475	496	499	496	523	561	613	657	679	739	807	810	867	888	932	994	1022	1077	1123	1140	1032	1244	1324
Excess	97	62	104	75	17	33	37	63	-6	35	27	53	10	-22	27	-30	-33	34	-16	2	76	71	115	26

Data Source: CDC WONDER

Figure 19 previously showed that the estimated excess number of cases of melanoma in 2022 was 400 relative to the U.S. as a whole. When compared only to states in the Iowa cluster, the estimated excess decreases to 26 excess cases and falls within the expected range (**Figure 56**). Although some excess cases were above expected range from 2019 to 2021, these levels were notably lower than those estimated based on national expectations. The cluster comparison provides context showing that melanoma in Iowa is more similar to the other states in its cluster than to the U.S. overall.

Figure 57. **Other cancers, ages 20+**: Iowa observed, expected, and excess cases relative to Iowa's cluster



Cases	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Observed	6173	6194	6564	6693	6903	7085	7100	7260	7373	7511	7879	7956	7972	8250	8168	8477	8542	8871	8671	8993	9159	8660	9431	9380
Expected	6137	6060	6484	6498	6568	6774	6829	7021	7211	7366	7426	7633	7919	7964	7998	8288	8354	8411	8500	8546	8809	8356	8903	8773
Excess	36	134	80	195	335	311	271	239	162	145	453	323	53	286	170	189	188	460	171	447	350	304	528	607

Data Source: CDC WONDER

Figure 20 previously showed that the estimated excess number of cases of all other cancers in 2022 was 1,145 relative to the U.S. as a whole. When compared only to states in the Iowa cluster, the estimated excess decreased to 607 excess cases but remained outside of the expected range (**Figure 57**). The cluster comparison provides context showing that the category of other cancers in Iowa is more similar to the other states in its cluster than to the U.S. overall, but it is still significantly elevated compared to the cluster.

Table 4. Iowa's excess cancer cases by cancer site relative to the U.S. versus excess cases relative to Iowa's cluster in 2022

Cancer.Site	**Excess Cases Relative to U.S.**	**Percent of Excess Cases Relative to U.S.**	**Excess Cases Relative to Cluster**	**Percent of Excess Cases Relative to Cluster**
Prostate	331	12.8%	66	5.1%
Female Breast	141	5.5%	64	4.9%
Lung	376	14.6%	329	25.3%
Colorectal	189	7.3%	206	15.9%
Melanoma	400	15.5%	26	2.0%
Other	1,145	44.3%	607	46.8%
Total	**2,582**	**100%**	**1,298**	**100%**

Table 4 summarizes the excess cases in Iowa for 2022 relative to the U.S. and shows a comparison of excess cases in Iowa for 2022 relative to Iowa's cluster. The excess cases relative to the U.S. and percent of excess cases relative to the U.S. columns in the table show the same numbers found in **Table 3**. The excess cases relative to cluster and percent of excess cases relative to cluster columns display the excess cases and percent of excess cases relative to Iowa's cluster (MN, NE, ND, SD, WI). In 2022, among site-specific cancers, Iowa experienced the most excess cases relative to its cluster from lung cancer followed by excess cases in colorectal cancer with those two cancer sites accounting for over 40% of the excess cases. Melanoma, which had the highest percentage of excess cases relative to the U.S., had the lowest percentage of excess cases when compared to Iowa's cluster.

Summary of State Clustering

The results outlined in the report thus far have highlighted that residents of states that cluster with Iowa (Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin) had similar demographic characteristics and self-reported cancer-related behavioral risk factors, and the cluster had the highest cancer rate of all clusters and the U.S. as a whole. Compared to states within the Iowa cluster, Iowa had among the highest rates of most common cancers. Also compared to other states in the Iowa cluster, Iowans had one of the highest percentages of people who were insured. This likely contributed to good access to healthcare among Iowans, which in turn may have contributed to Iowa's higher rates of early-stage cancers, and possibly to diagnoses of cancers that may have otherwise never been detected (e.g., prostate cancer). Within the Iowa cluster, Iowans ranked among the highest in binge drinking, obesity, and people consuming few vegetables, which likely increased the risk of many types of cancers, including female breast cancer. Compared to states in the Iowa cluster, Iowa stood out most for lung cancer, particularly higher age-adjusted incidence, late-stage incidence, and mortality. These methods and findings provided the necessary basis for the next phase of the analyses in which we sought to understand and map cancer rates and excess cases by county within Iowa while adjusting for behavioral risk factors and demographic characteristics.

County-Level Excess Cases in Iowa

To identify which counties have excess cancer cases beyond expected, three complementary methods were used. Multiple approaches allowed patterns to be examined via different statistical methods and identify counties that consistently stand out and may warrant further investigation. This interim report contains results for **female breast and prostate cancers**, which were the cancers used to develop these methods and models. Future reports will contain results for lung, melanoma, colorectal and HPV-related cancers.

Adjustment of expected cases

In addition to examining excess cancer cases overall, we also know that certain population characteristics are strongly associated with cancer risk. For example, it is widely documented that women who have their first child at older ages have a higher risk of developing breast cancer later in life. This reflects biological factors rather than behaviors that can or should be changed, and average maternal age varies across Iowa's counties in ways that could influence breast cancer incidence.

To account for differences in maternal age at first birth, we recalculate the expected number of female breast cancer cases with an adjustment. Using a simple linear

regression, we estimate how county-level breast cancer incidence relates to average maternal age at first birth. We then recalculate expected counts as if every county had the state-average maternal age at first birth. Adjusted excess is defined as the difference between the observed cases and these adjusted expected cases. This helps us assess whether the same counties remain high or low once we account for this known risk factor.

No well-established, consistently measured, population-level risk factors were identified for prostate cancer that warranted an adjustment of expected cases. It is important to note that adjustments are not meant to remove or minimize the importance of these factors, but instead to help us determine which counties' patterns of excess cancer cases persist even after accounting for these underlying differences. Such adjustments are made only when a risk factor is thoroughly documented, measured consistently, and can be meaningfully integrated into the modeling framework. Risk factors were identified through a combination of detailed scientific review, statistical variable selection, and machine learning approaches. A detailed list of risk factors for female breast and prostate cancer can be found in the **Appendix**.

Approach 1: Normative Range

Due to natural variation, two counties may have the same basic population distribution, but have different observed counts. Their observed counts can also change year to year. The difference between the counts does not necessarily mean that they are meaningfully or statistically different. We therefore aimed to determine if the observed counts were far enough away from the expected counts that the difference could not have happened by natural random variation. To determine this, we simulated 10,000 samples for each age-by-sex-by-county-by-year grouping. These simulations produce a robust estimate of excess cases across the various groupings of interest.

The simulation approach also produced an estimate of the range of excess cases that would be reasonable to expect for any given county due to normal variation. This reasonable range was referred to as a "normative range" and described trends that would be expected for a group if that group followed the national cancer trends. Each group's original excess cases were then compared to the calculated normative range:

- If a county's excess was above the upper limit of the normative range based on results from the 10,000 simulations, the county was classified as above the normative range, depending on how far beyond the range it fell.
- If a county's excess was below the lower limit of the normative range, the county was classified as below normative range, depending on the degree of deviation.

This approach determined whether a group's excess cancer was meaningfully higher or lower than what would be expected compared to national trends.

Figures 58–61 show county-level results for this normative range method for all cancer sites, prostate cancer, and female breast cancer over the three 5-year time periods.

Figure 58. **All Cancer Sites, Ages 20+** (unadjusted): Counties flagged outside of normative range

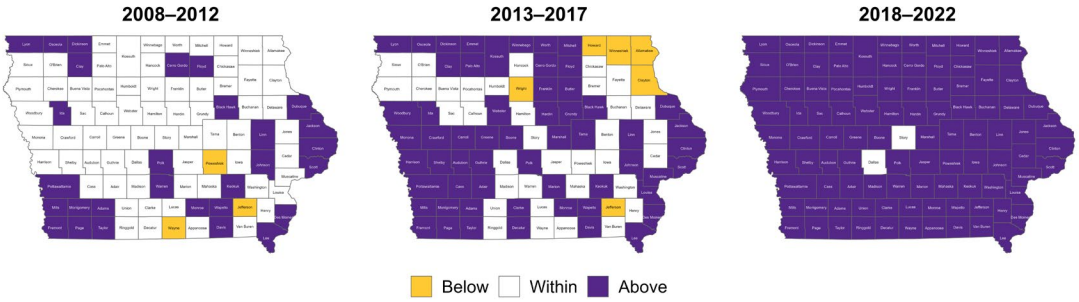


Figure 59. **Prostate Cancer, Ages 20+** (unadjusted): Counties flagged outside of normative range

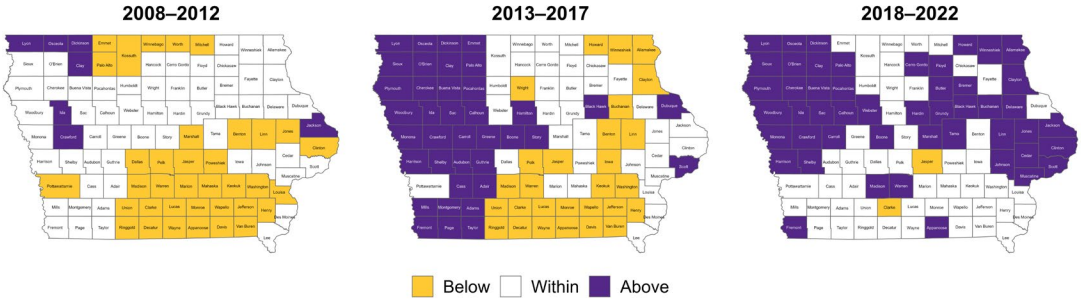


Figure 60. **Premenopausal Breast Cancer, Ages 20–44** (adjusted by average age of mother at first birth): Counties flagged outside of normative range

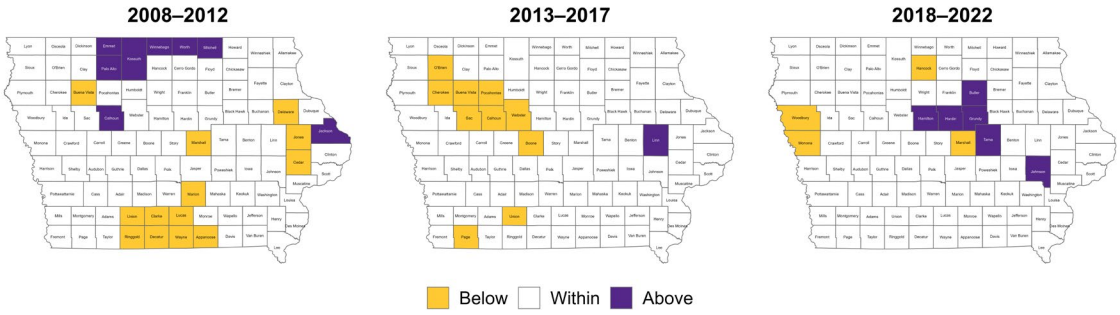
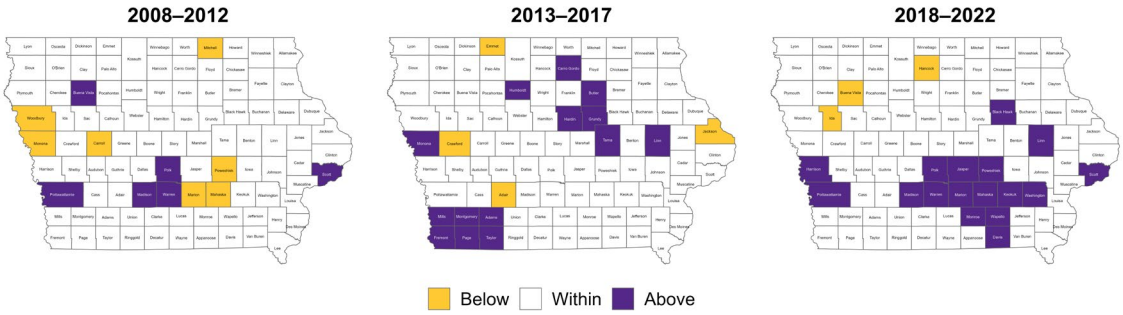


Figure 61**. Postmenopausal Breast Cancer, Ages 55+** (adjusted by average age of mother at first birth): Counties flagged outside of normative range



Approach 2: Standardized Excess

Approach 2 further accounted for the fact that counties have differing population sizes and therefore the natural amount of variability expected in the cancer counts also differed. Small absolute increases or decreases in cancer cases over time in less populated counties will result in larger relative changes than they would for larger counties. This needs to be taken into account when making comparisons across counties. To incorporate this variability, a method called standardization was applied to excess cases. The excess (observed – expected) for each county was divided by the square root of the expected cases for that county.

$$Standardized\ Excess = \frac{Observed - Expected}{\sqrt{Expected}}$$

These standardized excess values were then compared to a normal distribution with a newly simulated normative range, similar to Approach 1. Counties with unusually high or low excess relative to the level of naturally expected uncertainty for that county were identified. Counties falling above, within, or below this range were flagged.

Figures 62–65 show the results of this approach for all cancer sites, prostate cancer, and female breast cancer across the relevant age groups.

Figure 62. **All Cancer Sites, Ages 20+**: Counties flagged from standardized excess method

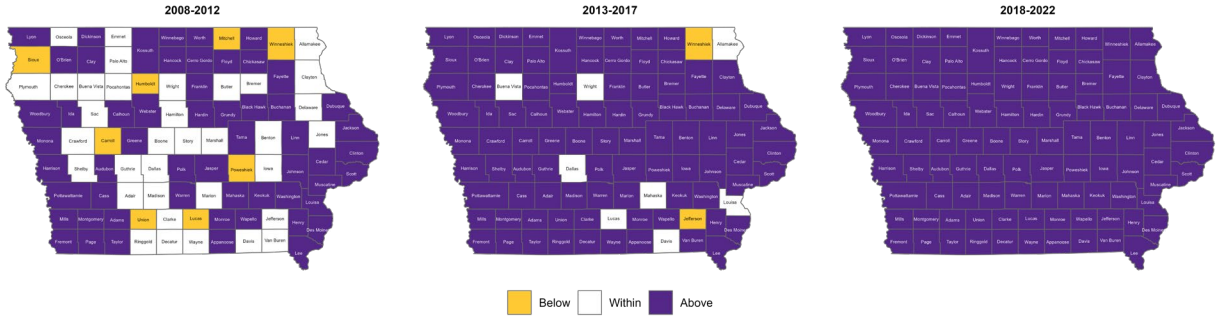


Figure 63. **Prostate Cancer, Ages 20+**: Counties flagged from standardized excess method

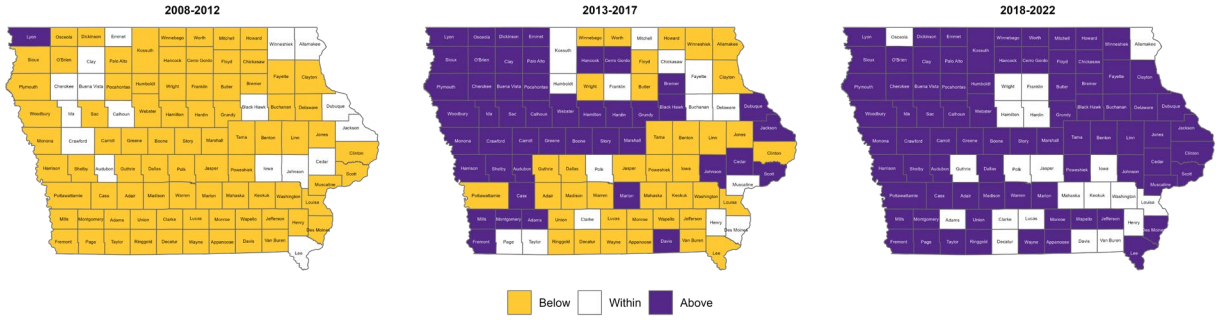


Figure 64. **Premenopausal Breast Cancer, Ages 20–44** (adjusted by average age of mother at first birth): Counties flagged from standardized excess method

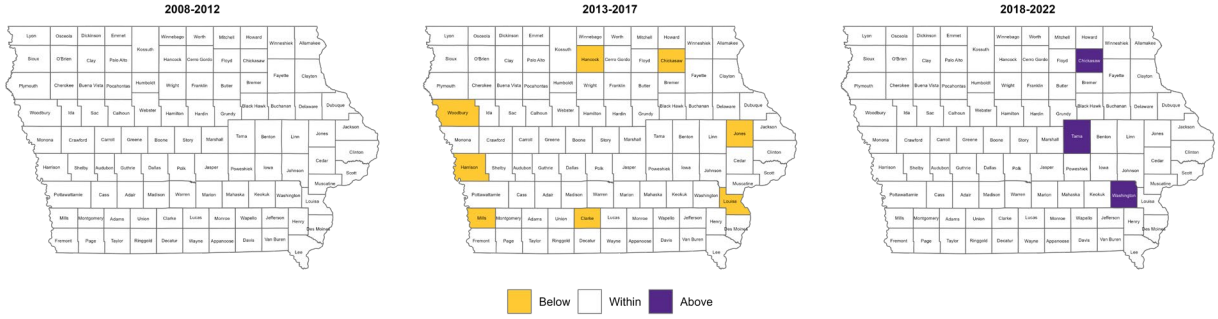
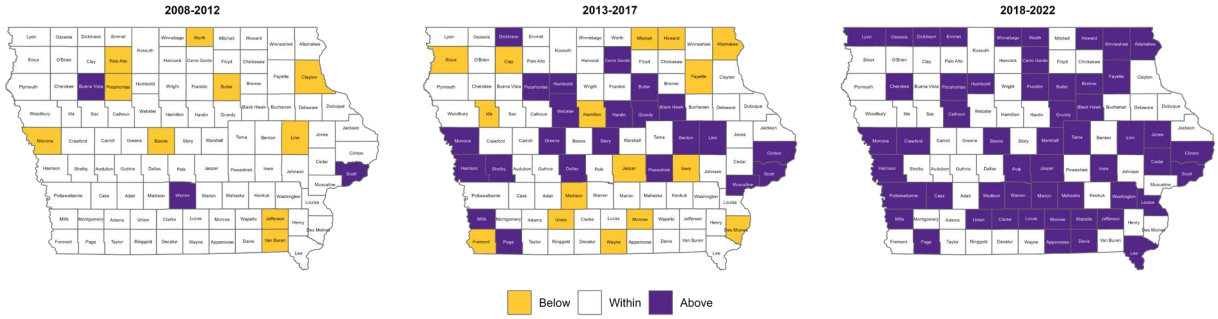


Figure 65. **Postmenopausal Breast Cancer, Ages 55+** (adjusted by average age of mother at first birth): Counties flagged from standardized excess method



Approach 3: Spatial Smoothing

Statistical disease mapping was performed to account for the fact that nearby geographic areas tend to be more similar than distant geographic areas. The statistical model borrows information from neighboring counties to estimate excess cancer in each county by adjusting for effects in the surrounding counties. For example, Polk County and Dallas County likely have demographics, healthcare access, and behaviors that are more similar than two counties located at greater geographical distance from one another.

Unlike the first two approaches, which focused on examining excess and variability at the individual county level, the spatial smoothing approach relied on a different statistical framework that explicitly incorporated geographic correlation into the model. This approach provided an important additional avenue for analysis that could identify broader regional patterns of excess.

This technique resulted in "spatially smoothed" maps of excess (**Figures 66-69**), where patterns of elevated or reduced cancer incidence could be identified more clearly, while also appropriately accounting for the fact that this was an analysis of geographic (county level) data.

Figure 66. **All Cancer Sites, Ages 20+**: Counties flagged from spatial smoothing

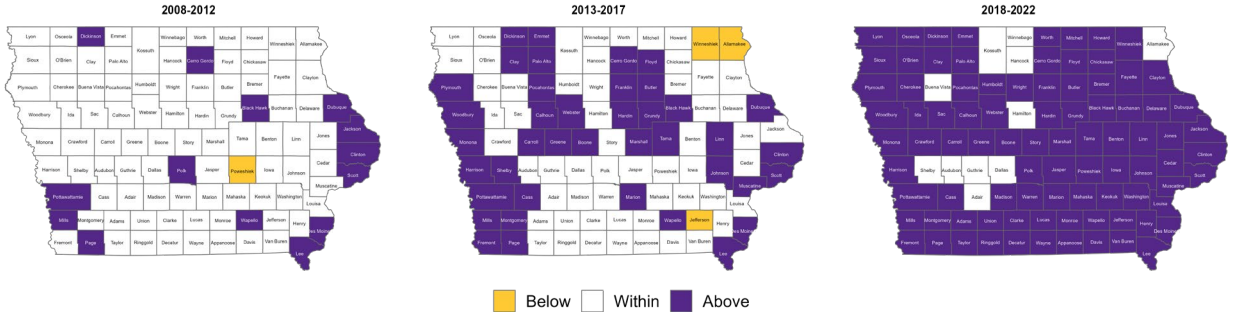


Figure 67. **Prostate Cancer, Ages 20+**: Counties flagged from spatial smoothing

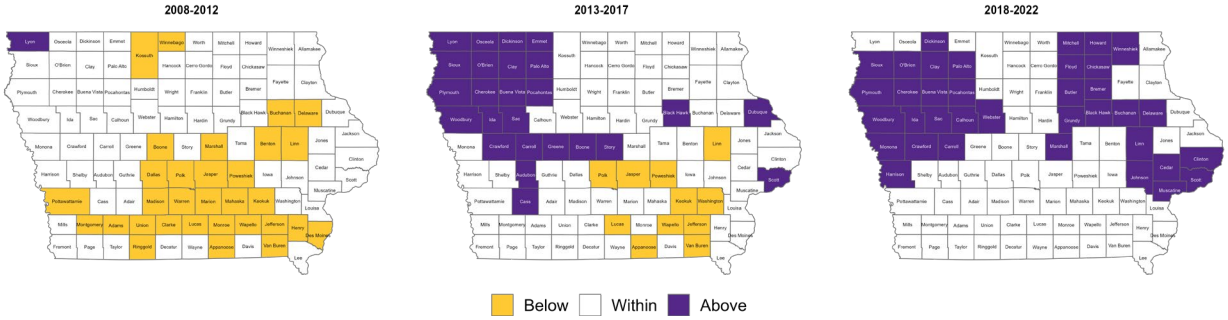


Figure 68**. Premenopausal Breast Cancer, Ages 20–44** (adjusted by average age of mother at first birth): Counties flagged from spatial smoothing

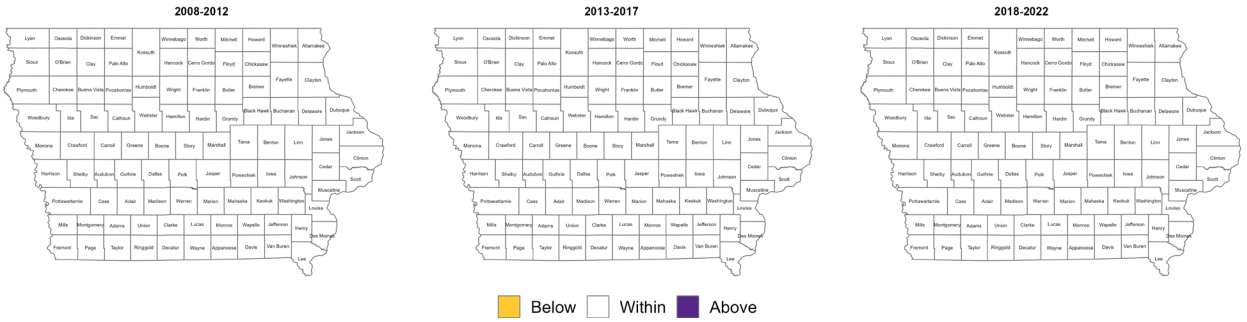
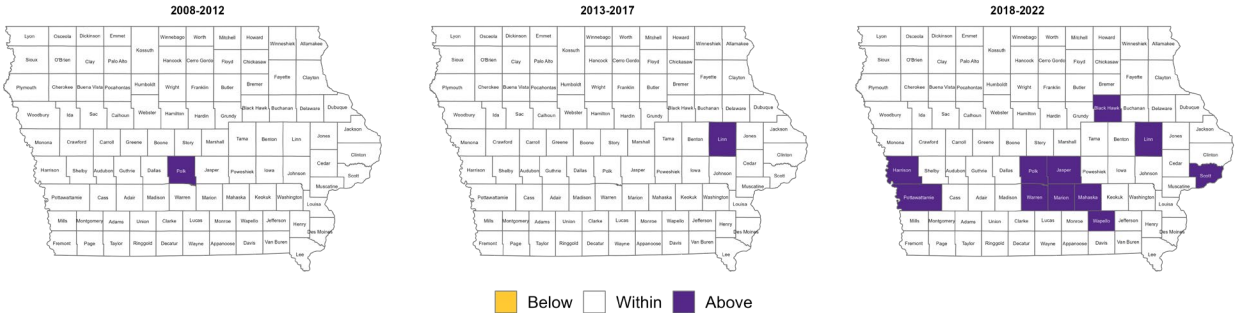


Figure 69. **Postmenopausal Breast Cancer, Ages 55+** (adjusted by average age of mother at first birth): Counties flagged from spatial smoothing



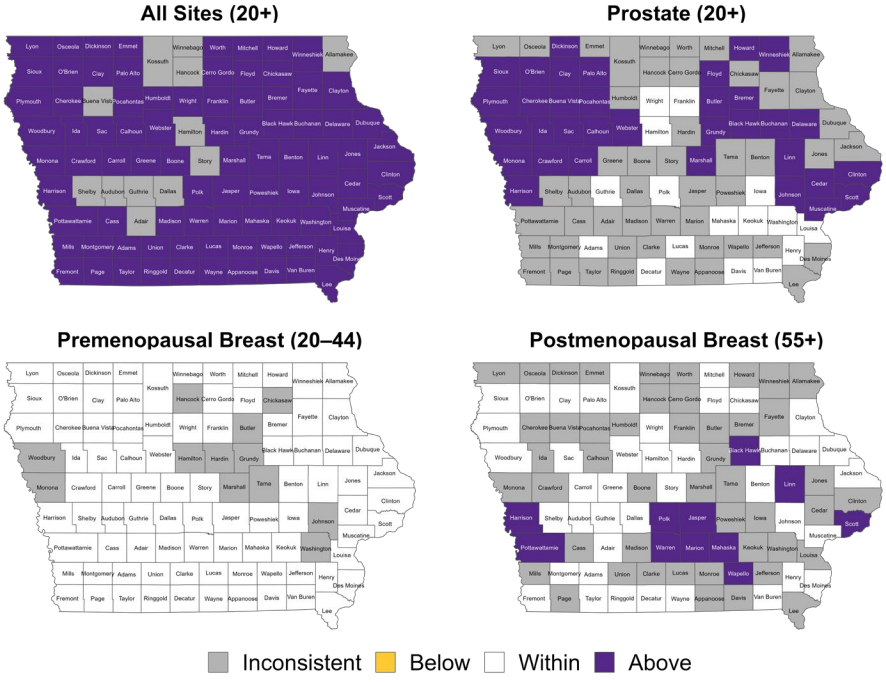
Combining Results from the Three Approaches

Results across the three statistical methods were combined to identify a set of counties that consistently demonstrated excess cancer cases beyond expected, not just due to model choice or method-specific behavior.

Figure 70 shows the combined results for all cancer sites, prostate cancer, and female breast cancer for the most recent time period (2018–2022).

- Purple counties were flagged as above expected levels in all three methods for the specific cancer type, indicating consistent signals of excess.
- White counties were consistently classified as within normative range across all three methods.
- Gray counties showed mixed results across methods (e.g., within range in one approach but above or below in another), indicating uncertainty and variation between statistical methods.
- Yellow would denote any counties that were consistently below normative range. Since no counties were consistently below normative range, there are no counties colored in yellow.

Figure 70. Consistently flagged counties across 3 methods for detecting excess (2018–2022)



Summary: The combined approach from all three methods showed that in 2018-2022, 87 of Iowa's 99 counties had a significantly higher number of excess cases of all cancer sites combined above what would be expected if each county had the same age-sex-specific rate as the US. For prostate cancer, 18 counties in west/northwest Iowa and 16 counties in east/northeast Iowa had a significantly higher number of excess cases of prostate cancer than would be expected. No Iowa counties had a significantly higher number of excess cases of premenopausal breast cancer, but 11 counties across Iowa had a significantly higher number of postmenopausal breast cancer, with 6 of the counties clustered together in central Iowa. While this approach highlighted which counties in Iowa have the highest numbers of excess cases of cancer, it did not take into account the demographic characteristics and behavioral risk factors of each county. As the state cluster analysis illustrated, these characteristics and factors have a large impact on cancer rates. We therefore constructed models to estimate what the cancer rates in Iowa, and in Iowa's individual counties, would look like after accounting for these characteristics and factors.

Multivariable Modeling between Cancer and Demographics, Behavioral Risk Factors, and Socioeconomic Status

The next step was to evaluate how demographic characteristics and behavioral risk factors were related to age-adjusted cancer rates at the state level. Results of this step served as the basis for predicting each state's age-adjusted cancer rate based on these demographic characteristics and behavioral risk factors.

The state-level models then served as the basis to predict each Iowa county's age-adjusted cancer rate based on the same set of demographic characteristics and behavioral risk factors. These county-level models allow us to identify which Iowa counties have higher than expected cancer rates after adjusting for these risk factors.

The following list of factors were considered for inclusion in the models (**Table 5**).

Table 5. Description of variables (2013–2017) used for modeling

Variable	Type	Operationalization.(percent.of.population.with.each. characteristic)
All.Cancer		
Obesity	Binary	BMI >=30 / BMI < 30
Alcohol	Binary	Binge drinking / Not binge drinking
Smoking	Binary	Former OR Current smoker / Non-smoker
Checkup	Binary	Checkup past year
Race	Binary	White / Non-White
Insurance	Binary	Any insurance / No insurance
Education	Binary	25+ bachelor's degree / No bachelor's degree
Prostate.Cancer		
Marital status	Binary	Married or partnered / Single, divorced, or widowed
Obesity	Binary	BMI <30 / BMI >=30
Race	Binary	Black / Non-Black
Alcohol	Binary	Binge drinking / Not binge drinking
Smoking	Binary	Former OR Current smoker / Non-smoker
PSA screening	Binary	40+ PSA screening within past 2 years / No PSA screening within past 2 years
Insurance	Binary	Any insurance / No insurance
Education	Binary	25+ bachelor's degree / No bachelor's degree
Female.Breast.Cancer		
Mother's age at first birth	Continuous	Average mother's age at first birth (1st child born alive to mother)
Obesity	Binary	BMI <30 / BMI >=30
Race	Binary	White / Non-White
Alcohol	Binary	Binge drinking / Not binge drinking
Smoking	Binary	Former OR Current smoker / Non-smoker
Mammography screening	Binary	Up to date / Never or not up to date
Insurance	Binary	Any insurance / No insurance
Education	Binary	25+ bachelor's degree / No bachelor's degree

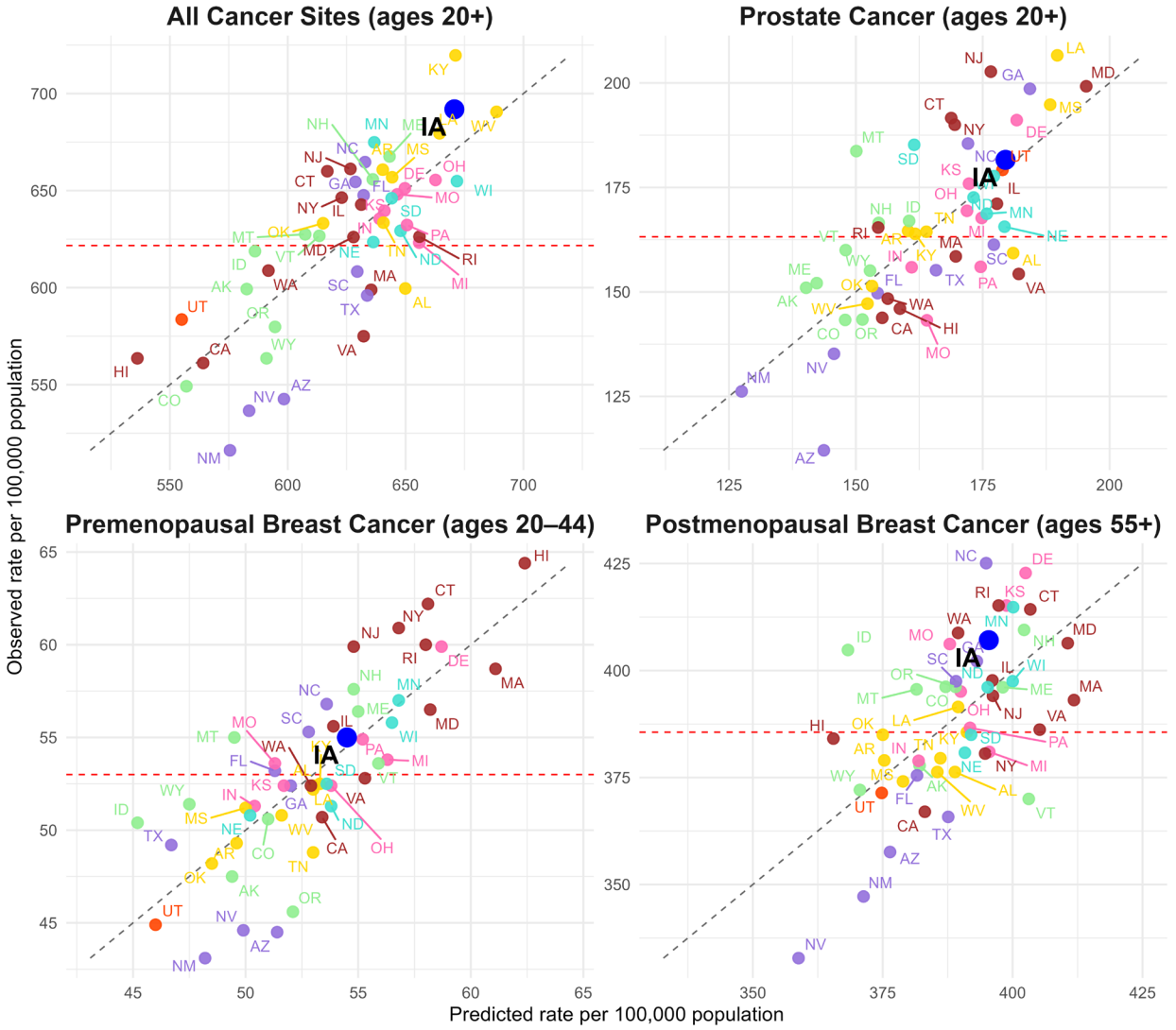
State-Level Modeling

We built separate models for each cancer type and age/sex group using all 50 states. In these models, the age-adjusted cancer incidence rate was the outcome variable, and the selected risk factors served as predictor variables. Model selection techniques were used to compare all combinations of possible predictors to determine the optimal model that provided the most explanation for the differences in Iowa's cancer rates when compared to

the rest of the states, while also highlighting risk factors that are known to be important when analyzing cancer trends. The resulting estimates represent the relationship between state-level risk factors and cancer rates. These estimates were then applied to Iowa's county-level risk factor and demographic data to generate predicted cancer rates for each county.

The scatterplots in **Figure 71** show how closely the model-predicted cancer rates align with the observed state-level rates across the 50 states for each cancer site. Each point represents a U.S. state. The dashed gray line indicates equality between observed and predicted incidence rates (Observed = Predicted), and the dashed red line indicates the U.S. national age-adjusted incidence rate for the corresponding cancer type and age group. Panels show all cancer sites (ages 20+), prostate cancer (ages 20+), premenopausal breast cancer (ages 20–44), and postmenopausal breast cancer (ages 55+).

Figure 71. State-level observed versus predicted age-adjusted cancer incidence rates where states are colored according to their cluster membership



Points that fall near the diagonal line indicate stronger agreement between predicted and observed incidence rates. **Table 6** provides a numerical summary of this agreement showing Iowa's observed age-adjusted rate versus the model predicted age-adjusted rate. Across cancer sites, the models explain between 38% to 62% of the variability between the states' age-adjusted rates. This suggests that the risk factors included in the analysis account for a meaningful portion of the differences in cancer rates across states.

Table 6. Observed and model-predicted age-adjusted cancer incidence rates in Iowa compared with U.S. rates, by cancer site

	Per 100,000 Population			
	U.S. Rate	**Observed Iowa Rate**	**Model Predicted Rate for Iowa**	**Variables Included in Model**
All Cancer Sites	622	692	671	% Obese, % Binge drinking, % Checkup in past year, % White population
Prostate Cancer	163	182	180	% Married, % Obese, % Binge drinking, % Never smoked, % PSA screening within past 2 years, % Insured, % Black population
Premenopausal Breast Cancer	53	55	55	% Binge drinking, % Never smoked, % Up-to-date with mammogram, % Insured, % White population
Postmenopausal Breast Cancer	386	407	395	% Obese, % Binge drinking, % Up-to-date with mammogram, % with Bachelor's degree, % White population

Models accounting for demographic characteristics and behavioral risk factors shown in **Table 6** suggest that Iowa's cancer rates should be somewhat higher than those in the U.S. overall (based on these known risk factors and demographic characteristics in Iowa). However, Iowa's overall cancer rate (692/100,000) is still higher than what the model predicted (671/100,000). This remaining difference suggests that even after considering the available behavioral risk factors and demographic characteristics, additional factors influencing Iowa's cancer rate may not be fully captured by the model. These could include genetic or environmental factors, or other risk factors that were not represented in the available data sources. Similarly, the model for postmenopausal breast cancer suggested that Iowa's rate should be higher than the U.S. based on the predictor variables, but Iowa's postmenopausal breast cancer rate (407/100,000) is higher than the predicted rate for Iowa (395/100,000).

Iowa's prostate cancer rate (182/100,000) is close to the predicted rate (180/100,000), suggesting that predictor variables largely explain Iowa's rate. Similarly, Iowa's premenopausal breast cancer rate is 55/100,000, which is identical to the predicted rate for Iowa.

We then applied the coefficients from the state-level models to Iowa's county-level data. This allows us to identify counties with the highest rates of all cancer sites combined, prostate cancer, premenopausal and postmenopausal breast cancer that cannot be fully explained by the predictor variables included in the models.

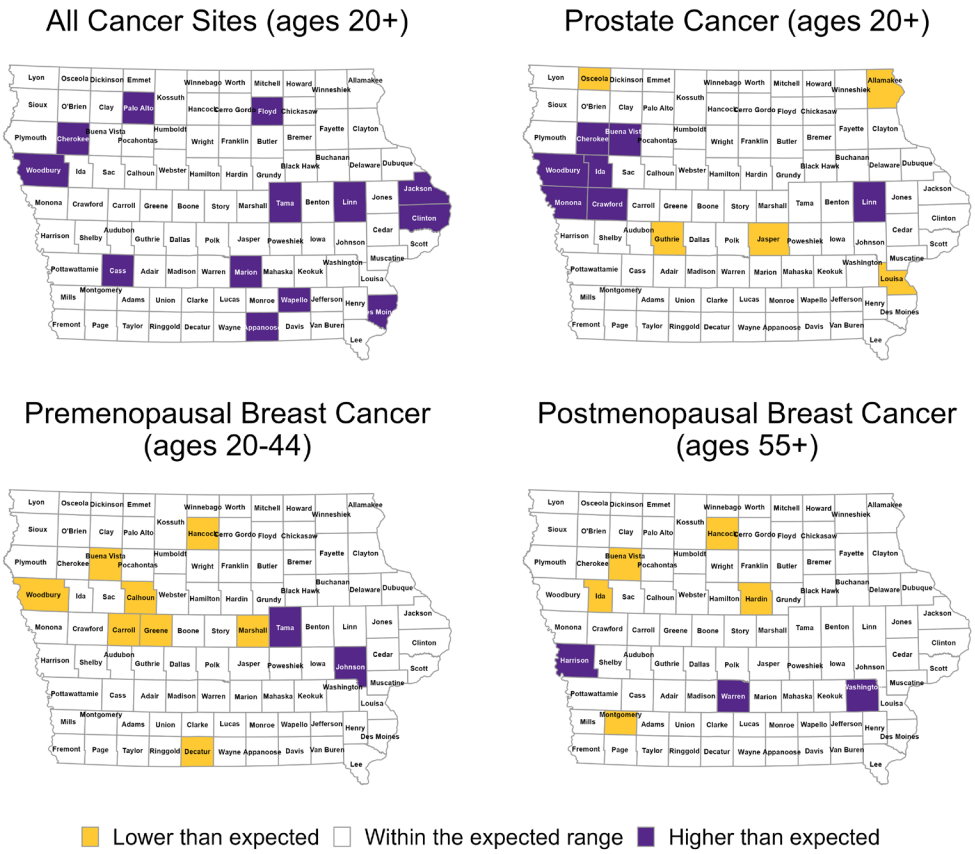
County-Level Estimates

We compared the observed age-adjusted incidence rates for each county in Iowa to their respective predicted rate generated from the state-level model. Each county also received an uncertainty range (confidence or prediction interval), allowing for classification that accounts for statistical variability. The BRFSS, which is the source of the behavioral risk factor variables used in the models, was designed to produce reliable estimates at the state level. County-level behavioral risk factor estimates may not be as reliable, particularly for counties with small populations. We used spatial smoothing to yield more reliable county-level estimates for behavioral risk factors that were included in the regression models.

A statistical testing method was used to determine whether the observed cancer incidence rate in each county differed from the predicted rate beyond what would be expected by random variation. Counties were categorized into three groups: "Below", "Within", and "Above", offering a more sensitive view of departures from the expected pattern.

Figure 72 displays counties identified as having lower than expected (yellow), expected (white), and higher than expected (purple) cancer rates after adjustment for behavioral risk factors and demographic characteristics for all cancers combined, prostate, premenopausal breast, and postmenopausal breast cancer.

Figure 72. Counties identified after adjusting for risk factors



All cancer sites (ages 20+) included adjustment for % obesity, % binge drinking, % checkup (within past year), and % White population. Thirteen of Iowa's 99 counties have a cancer incidence rate that was significantly higher than expected, and no counties had a lower than expected rate.

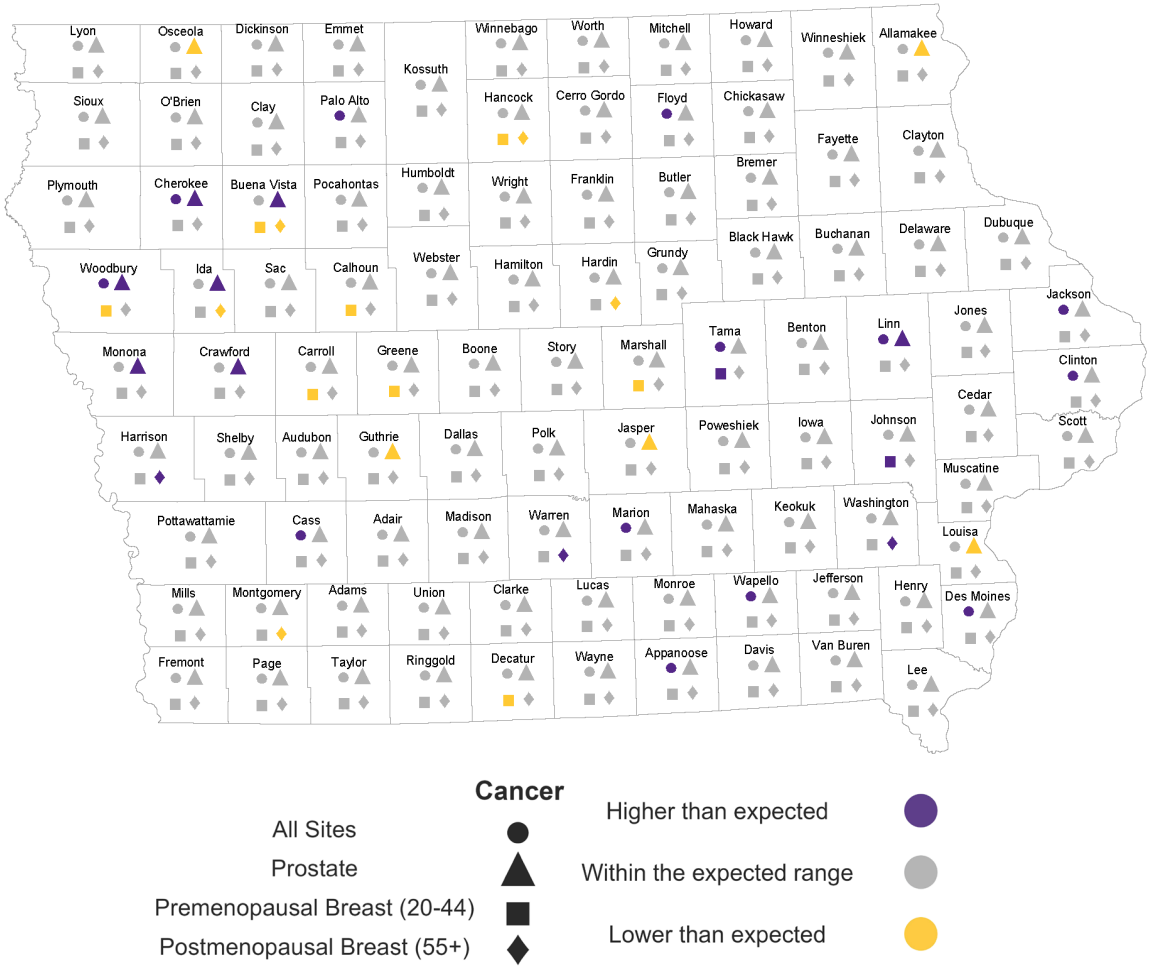
For prostate cancer (ages 20+), after adjusting for % PSA screening (within past 2 years), % insured (age 19+), % married/partnered, % Black population, % never smoked, % binge drinking, and % obese, six northwestern Iowa counties plus Linn county had a significantly higher than expected rate of prostate cancer after adjustment, and five counties had a significantly lower than expected rate.

For premenopausal breast cancer (ages 20–44), after adjusting for % mammogram (up to date), % insured (age 19+), % White population, % never smoked, and % binge drinking, two Iowa counties (Tama and Johnson) had a significantly higher than expected rate of premenopausal breast cancer after adjustment, and eight counties had a lower than expected rate.

For postmenopausal breast cancer (ages 55+), after adjusting for % mammogram (up to date), % insured (age 19+), % White population, % never smoked, and % binge drinking, three counties (Harrison, Warren and Washington) had a significantly higher than expected rate of postmenopausal breast cancer after adjustment, and five counties had a lower than expected rate.

Figure 73 presents a combined map of results for all cancer sites, prostate cancer, and both premenopausal and postmenopausal breast cancer, showing which counties fall above or below the expected range across these cancer types after controlling for risk factors.

Figure 73. Counties flagged as above or below the expected range after adjustment for risk factors



After adjusting for behavioral and demographic risk factors, Cherokee County, Woodbury County, and Linn County remained above the expected range for all cancers combined and prostate cancer. Tama County remained above the expected range for all cancers combined and premenopausal breast cancer.

The counties with higher than expected rates after adjustment for behavioral risk factors and demographic characteristics represent the best opportunities to explore other types of risk factors, such as local environmental exposures, provider screening patterns, or genetic factors that were not captured in the model. Future reports will include mapping and

modeling results for lung cancer, melanoma, colorectal cancer and HPV-associated cancers.

Project Aim 2

Investigate the possible role of provider screening behavior in the increased incidence rate of prostate cancer in Iowa.

Aim 2a

Conduct a separate assessment that examines provider behavior around screening recommendations for prostate cancer.

Aim 2 Progress Updates

The following Aim 2 activities are ongoing:

- Reviewing data from Aim 1 to understand the role of screening: We are reviewing the analyses conducted under Aim 1 to assess where screening rates may be higher than predicted.

- Midwest insurance claims analyses: The analysis team is working with insurance claims from a midwestern insurance company to assess provider screening behavior among patients that are covered by private insurance.

- Medicare/Medicare Advantage analyses: We are also analyzing Medicare and Medicare Advantage claims data to assess provider screening behavior for patients that are covered by Medicare.

- Literature Review: A literature review is was conducted to examine the connection between recommended screening guidelines and incidence rate, as well as interpretations of PSA screening results and referral patterns based on those results. The literature review found strong evidence that screening guidelines recommended by the USPTF drive screening behaviors, evidenced by a sharp decline in screening rates after the guideline changes in 2008 and 2012. Following reductions in rates of screening, rates of localized prostate cancer dropped

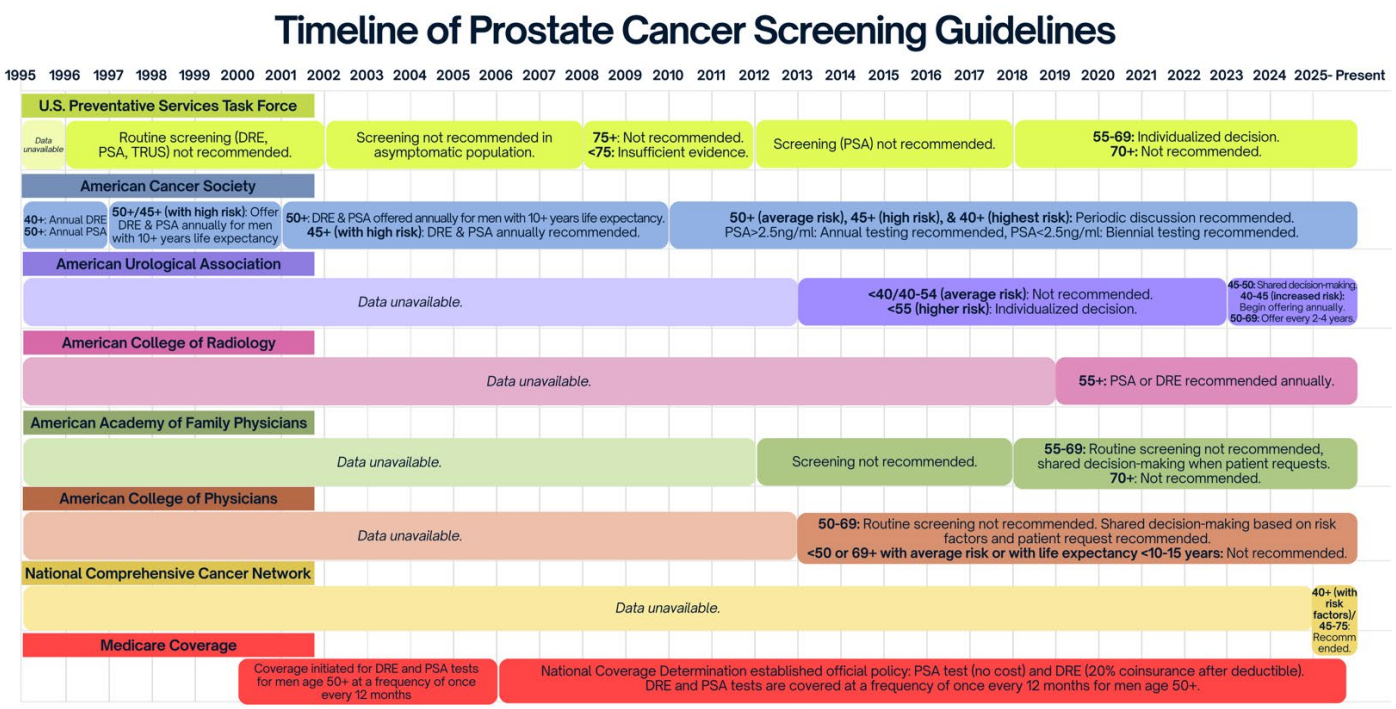
significantly, while distant/metastatic incidence increased steadily. Studies show that more frequent screening reduces advanced disease risk, though it increases overall diagnosis rates.

Aim 2a Activities

- **Literature review**: We conducted a comprehensive literature review to identify studies examining provider perspectives, attitudes, and reported practices related to prostate cancer screening. This work focused on understanding how clinicians interpret and apply screening guidelines, as well as the factors that shape their decision-making in clinical settings.

  Across the literature, primary care physicians (PCPs) demonstrated wide variation in prostate cancer screening practices, often influenced by inconsistent knowledge of risk factors and guideline recommendations. Providers differed substantially in their approaches—ranging from routinely screening all eligible men to selectively screening based on risk, or only doing so upon patient request. Decisions were shaped by factors such as family history, race, patient preference, low confidence in PSA testing's mortality benefit, training, perceived medico-legal concerns, and community norms. Provider characteristics, including age, gender, and specialty, also influenced screening behaviors, particularly in care provided to Black patients.

- **Timeline**: A timeline was created to illustrate how prostate cancer screening guidelines from the U.S. Preventive Services Task Force (USPSTF) and other major medical organizations have evolved over the last 30 years, and how these changes relate to shifts in screening practices and prostate cancer detection. This timeline also incorporates the history of Medicare coverage for prostate cancer screening, providing a comprehensive view of how clinical recommendations and coverage policies have aligned with observed trends.



Next Steps

The team is continuing to work with the data analysis teams to conduct further analysis tailored to factors relevant to Aim 2.

Regarding Aim 2a, we are in the process of planning formative interviews with primary care physicians and urologists. To identify useful and valid questions for the interviews, we have reviewed survey instruments and interview guides from the literature review. Interviews will be guided by the following research questions:

- Which set of guidelines does the provider rely on when making decisions about screening, if any?
- What factors does the provider consider when making a screening recommendation, if any?
- What factors do providers consider when considering or making a referral to a urologist for screening?

We will identify potential interviewees using our partners and the University of Iowa health care provider tracking database. We will use maximum variation sampling (rural/urban, 4

quadrants of state, & health systems) to make sure that those that are interviewed represent the range of experiences of providers. Recruitment of potential interviewees will begin in early January 2026. Interviews will take place between mid-January and mid-February.

A survey will be created based on the findings of the interviews, the data collection instruments gathered in the literature review, and surveys identified through a survey repository. The survey will be conducted in February and March 2026. The data gathered from the survey will be used to document provider screening behavior.

Aim 3

Identify and model successful population level health interventions.

Aim 3a

Undertake a review to identify successful population health interventions, including policies and legislation, that have been adopted by other states and have been found to move the needle on these cancers and their risks.

Aim 3b

Compile detailed resource list of these interventions and conduct a SWOT analysis to identify how appropriate the interventions are for Iowa.

Aim 3c

Model the identified successful and suitable interventions to calculate potential impact on cancer mortality, years of productive life lost, and cost-benefit of the intervention.

Progress Updates

Aim 3a

A comprehensive review of evidence-based interventions to reduce cancer burden was conducted to locate the following types of resources:

- Ready-to-use EBIs (programs or accompanying resources) that have been research-tested to prove effectiveness at reaching clearly defined outcomes
- Proven strategies for implementation at organizational and community levels
- Stave-level policy approaches with demonstrated success

We searched for resources evidenced to be effective at addressing the following cancers:

- Alcohol-related cancers (mouth, throat, esophagus, liver, colorectal, and breast cancers)
- Breast cancer
- Colorectal cancer
- HPV-related cancers (cervical, anal, penile, vaginal, vulvar, and oropharyngeal cancers)
- Lung cancer
- Melanoma
- Prostate cancer

Our search criteria also included 11 risk factors relevant to the selected cancers, which were identified by cancer experts on the Blue Ribbon Panel. The Holden Comprehensive Cancer Center spearheaded the Blue Ribbon Panel, an effort to engage internationally recognized cancer and cancer risk factors experts in a process that resulted in a research agenda designed to understand what is contributing to Iowa's high and rising cancer incidence rates. The following known cancer risk factors were included in the review:

- Diet and nutrition
- Physical activity
- Obesity/BMI
- Tobacco use
- Alcohol consumption
- Radon exposure
- Sun Exposure/Indoor tanning
- Not breastfeeding
- Insufficient access to healthcare
- Water contamination (e.g., heavy metals, nitrates)
- Agrochemical exposure

The research team compiled a list of 10 known databases that house or aggregate evidence-based interventions, proven strategies, and evidence-based policies to increase public health. Two databases were eliminated from the list: one that contained only resources for implementation in the K-12 school system, and one that focused on cancer awareness resources and cancer-patient-focused resources.

Table 7 depicts the databases utilized for the review and the methods for reviewing each database.

Table 7. Methods.

Database	Methods	Filters applied and/or search terms used
Evidence-Based Cancer Control Programs (EBCCP) *National Cancer Institute (NCI)*	Filtered all resources by program area	Alcohol use Breast cancer screening Cervical cancer screening Colorectal cancer screening Diet and nutrition HPV vaccination Lung cancer screening Obesity management Physical activity Prostate cancer screening Sun safety and indoor tanning Tobacco control
The Community Guide *The Community Preventive Services Task Force (CPSTF)*	Filtered all resources by topic	Cancer Excessive alcohol consumption Nutrition Obesity Physical activity Substance use Tobacco Vaccination Worksite health
Pathway to Practice (P2P) *U.S. Centers for Disease Control (CDC)*	Filtered all resources by health topic	Cancer Nutrition Overweight/Obesity Physical Activity Substance use Tobacco Vaccines/immunizations Other chronic condition or disease
Evidence-Based Practices Resource Center *Substance Abuse and Mental Health Services Administration (SAMHSA)*	Filtered all resources by substance and resource topic	Alcohol Use Prevention
Healthy People 2030	Filtered all resources by health conditions,	Cancer Oral conditions Obesity

Database	Methods	Filters applied and/or search terms used
Office of Disease Prevention and Health Promotion (ODPHP)	health behaviors, settings/systems	Drug and alcohol use Family planning Nutrition and healthy eating Physical activity Preventative care Tobacco use Vaccination Health policy Environmental health Health care access and quality
Results First Clearinghouse *Penn State University Social Science Research Institute*	Filtered all resources by category and by evidence rating	Public health Substance use Evidence ratings: green (positive impact based on the most rigorous evidence) and yellow (positive impact based on high-quality evidence)
Social Programs That Work *Arnold Ventures Philanthropic Organization Policy Team*	Reviewed all resources by policy area	Chronic disease prevention Pre-natal/early childhood
Evidence-Based Policies & Practices Database *U.S. Department of Health and Human Services (HHS) Assistant Secretary for Planning and Evaluation (ASPE)*	Filtered by type of resource, searched with search terms	Policy and regulation Public health reports Breast cancer Colorectal cancer HPV-related cancers Lung cancer Melanoma Prostate cancer Radon Healthcare access

Additional resources were located through a review of the relevant scientific literature and targeted web searches by cancer type, risk factors, and related policy areas.

Aim 3b

The SWOT analysis will begin in January 2026. This will include a systematic review of each intervention and its applicability in Iowa.

Aim 3c

We are currently planning the modeling that will be applied to the evidence-based interventions that are appropriate for Iowa, based on Aim 1 findings and the SWOT analysis.

Results

Aim 3a

A collection of 272 resources was compiled. The following tables summarize the types of resources included in the results (Table 8), and the number of resources pertaining to each cancer (Table 9) and each identified risk factor (Table 10).

Table 8. Types of Resources.

Resources	Number of Resources
Packaged EBIs	161
Toolkits	5
Proven strategies	68
Evidence-based policies	17
Other Resources	29 (screening tools, policy guidance, fact sheets, government reports, research articles)

**Proven strategies and evidence-based policy categories are not mutually exclusive, some resources are indicated in both categories*.

Table 9. Resources by Type of Cancer.

Cancers	Number of Resources
All cancers	190
Lung cancer	57
Breast cancer	36
Colorectal cancer	32
HPV-related cancers	32
Melanoma	19
Alcohol-related cancers	9
Prostate cancer	4

** Resources may apply to more than one cancer.*

Table 4 indicates the number of resources for each factor known to increase the risk of one or more type of cancer.

Table 10. Resources by Risk Factor.

Cancer Risk Factors	Number of Resources
Physical Activity	61
Tobacco use	48
Obesity	36
Diet and Nutrition	32
Sun Exposure/ Indoor Tanning	19
Not breastfeeding	10
Alcohol consumption	8
Insufficient access to Healthcare	8
Radon exposure	8
Water contamination (well testing laws)	5
Agrochemical exposure	0

**Resources may apply to more than one risk factor.*

In addition to the modifiable risk factors included in the review, some resources for the healthcare setting also address unmodifiable risk factors such as age, family history and biology.

Challenges

Aim 3a

In the review of evidence-based policy approaches, the research team found that while many organizations advocate for policies to increase public health, there is sometimes a challenging disconnect between policy advocacy and direct evidence of impact on cancer rates. This is likely due to the difficulty of isolating the effects of individual policies amid numerous contributing factors since screening uptake, lifestyle, access to care, and other variables all interact in complex ways.

While completing the review, the research team encountered gaps in available public health data on federal websites. Websites for agencies such as the CDC and National Institutes of Health (NIH) displayed notifications that the websites were under review due to an Executive Order and links to some data were non-functioning. It is unknown the extent to which this impacted the review of existing resources.

Aim 3b

No challenges have been identified at this stage.

Aim 3c

No challenges have been identified at this stage.

Next Steps

Aim 3a

The research team will focus on structuring the collected resources in a way that maximizes usability for Iowa HHS, supporting the ability to identify and apply the most appropriate tools for reducing cancer burden in Iowa.

Aim 3b

In late December 2025, the team began to meet about the SWOT analysis. The compiled resources will be further reviewed and analyzed based on relevance to the Iowa context. Beginning early in 2026, we will assess implementation considerations and conduct a structured SWOT analysis, ensuring interventions are evaluated in a transparent and organized way, providing a clear foundation for subsequent decision-making.

Aim 3c

We plan to initiate Aim 3c in early spring 2026, subsequent to the completion of Aim 3b.

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Appendix Supplementary Table 1: Prostate Cancer Risk Factors

Prostate cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
Established associations (Evidence level HIGH): Consistent epidemiologic findings across a large number of well-designed studies. Shows a dose-response relationship, has a biologically possible mechanism, and has supportive laboratory evidence.						
Demographics						
Age	Risk increases after age 50	Increased	• Incidence • Mortality	Yes	Analyses are age-adjusted	NCI, CDC, ACS, Cancer Research UK, John Hopkins, Mayo, Cleveland Clinic, Leitzmann, et al., Gann, et al., https://www.cdc.gov/united-states-cancer-statistics/publications/prostate-cancer.html, https://seer.cancer.gov/statfacts/html/prost.html
Race	Higher rates among African Americans	Increased	• Incidence • Mortality • Age at onset • Disease severity	Yes	Yes	NCI, CDC, ACS, Cancer Research UK, John Hopkins, Mayo, Cleveland Clinic, Leitzmann, et al., Gann, et al., https://seer.cancer.gov/statfacts/html/prost.html, https://pmc.ncbi.nlm.nih.gov/articles/PMC9701576/, https://www.nature.com/articles/s41585-024-00948-x
Genetics and family history						
Family history		Increased	• Incidence	No	No	NCI, CDC, ACS, Cancer Research UK, John Hopkins, Mayo, Cleveland Clinic, Leitzmann, et al., Gann, et al., https://pmc.ncbi.nlm.nih.gov/articles/PMC6986340/, https://www.cancer.gov/types/prostate/hp/prostate-genetics-pdq, https://pmc.ncbi.nlm.nih.gov/articles/PMC6279573/
Inherited gene mutations	BRCA1, BRCA2, and Lynch Syndrome	Increased	• Incidence	No	No	NCI, CDC, ACS, Cancer Research UK, John Hopkins, Mayo, Cleveland Clinic, Leitzmann, et al. Gann, et al., https://www.cancer.gov/types/prostate/hp/prostate-genetics-pdq, https://pmc.ncbi.nlm.nih.gov/articles/PMC7001059/, https://pmc.ncbi.nlm.nih.gov/articles/PMC3720154/
Probable associations (Evidence level MODERATE): Epidemiological evidence is largely consistent but is not as extensive as the established associations to draw a solid conclusion.						
Diet and dietary supplements						
Dairy	Excessive calcium intake	Increased	• Incidence	No	No	ACS, NCI, Leitzmann, et al., Gann, et al., https://pubmed.ncbi.nlm.nih.gov/11857417/, https://pubmed.ncbi.nlm.nih.gov/20232354/, https://pubmed.ncbi.nlm.nih.gov/17278090/
Vitamin E	Specifically from excess supplementation	Increased	• Incidence	No	No	NCI, Leitzmann, et al., Gann, et al., https://jamanetwork.com/journals/jama/fullarticle/1104493, https://www.nature.com/articles/s41598-019-48213-1, https://ascopubs.org/doi/10.1200/jco.2012.30.5_suppl.7

Prostate cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
Chemical exposures						
Arsenic		Increased	• Incidence	Limited	No*	ACS, John Hopkins, Cleveland Clinic, https://pmc.ncbi.nlm.nih.gov/articles/PMC2235216/, https://pubmed.ncbi.nlm.nih.gov/35550984/, https://stacks.cdc.gov/view/cdc/39526
Agent Orange		Increased	• Incidence	No	No	ACS, John Hopkins, Cleveland Clinic, https://pmc.ncbi.nlm.nih.gov/articles/PMC2235216/, https://pubmed.ncbi.nlm.nih.gov/35550984/, https://stacks.cdc.gov/view/cdc/39526, https://www.sciencedirect.com/science/article/pii/S0013935117311180
Pesticide exposure	Organochlorine, organophosphate, insecticide, dimethoate, triclopyr	Increased	• Incidence • Mortality Cancer sub-type	Limited	No*	Cancer Research UK, https://pubmed.ncbi.nlm.nih.gov/39492609, https://academic.oup.com/aje/article/157/9/800/97345, https://link.springer.com/article/10.1007/s10552-015-0643-z, https://pubmed.ncbi.nlm.nih.gov/27244877/, https://pubmed.ncbi.nlm.nih.gov/33495906/
Hormones						
Intraprostatic androgens		Increased	• Progression • Recurrence	No	No	NCI, Cancer Research UK, Leitzmann, et al., Gann, et al., https://pubmed.ncbi.nlm.nih.gov/17510436/, https://aacrjournals.org/cancerres/article/67/10/5033/533107/Intraprostatic-Androgens-and-Androgen-Regulated
Location						
Geographic location	Increased risk in higher income countries (Northern/western EUR, USA, AU)	Increased	• Incidence	Yes	Analysis is for Iowa and U.S.	Leitzmann, et al., https://pubmed.ncbi.nlm.nih.gov/30203706/, https://www.sciencedirect.com/science/article/pii/S0302283824027076, https://pmc.ncbi.nlm.nih.gov/articles/PMC6199451/
Behavioral / lifestyle / modifiable factors						
Sexual activity		Decreased	• Incidence	No	No	https://www.nature.com/articles/nrurol.2009.34, https://www.health.harvard.edu/mens-health/ejaculation_frequency_and_prostate_cancer, https://pubmed.ncbi.nlm.nih.gov/30122473/
Possible associations (Evidence level LIMITED): Recognized as potentially linked (or not linked in some cases) to prostate cancer. More study is needed before solid conclusions can be made. Epidemiologic findings are supportive but limited in quantity or quality. Results are generally consistent,						

Prostate cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
but only hint at a possible relationship. Supportive laboratory evidence may or may not be available. May not be a clear biological reason the factor might be linked to risk. These factors are still under study.						
Behavioral / lifestyle / modifiable factors						
Obesity		Increased	• Mortality • Disease severity	Yes	Yes	ACS, Cancer Research UK, Mayo, Cleveland Clinic, Leitzmann, et al., Gann, et al., https://pmc.ncbi.nlm.nih.gov/articles/PMC1550782/, https://www.nature.com/articles/s41585-023-00764-9, https://academic.oup.com/jnci/article/115/12/1506/7210260
Smoking		Increased	• Mortality • Disease severity recurrence	Yes	Yes	ACS, Mayo, Cleveland Clinic, Leitzmann, et al., https://jamanetwork.com/journals/jamaoncology/fullarticle/2682189, https://pmc.ncbi.nlm.nih.gov/articles/PMC2836346/, https://www.sciencedirect.com/science/article/pii/S0302283822018048
Alcohol	Specifically long-term alcohol use	Increased	• Incidence • Mortality • Disease severity • Cancer sub-type	Yes	Yes	Leitzmann, et al., https://pmc.ncbi.nlm.nih.gov/articles/PMC2739798/, https://ascopubs.org/doi/10.1200/JCO.18.02462, https://bmccancer.biomedcentral.com/articles/10.1186/s12885-016-2891-z, https://academic.oup.com/ije/article/30/4/749/705912
Physical activity		Decreased	• Incidence • Mortality • Progression	Yes	Yes	Leitzmann, et al., https://doi.org/10.1016/j.eururo.2011.07.007, https://pmc.ncbi.nlm.nih.gov/articles/PMC3107352/, https://www.nature.com/articles/s41391-022-00509-6
STIs		Increased	• Incidence	No	No	ACS, Cleveland Clinic, Leitzmann, et al., https://pmc.ncbi.nlm.nih.gov/articles/PMC2559953/, https://www.sciencedirect.com/science/article/pii/S1877782114001052, https://www.sciencedirect.com/science/article/pii/S1877782125000414, https://www.nature.com/articles/6690986.pdf
Anatomy / health conditions						
Inflammation	Specifically of the prostate	Increased	• Incidence	No	No	ACS, Cancer Research UK, Cleveland Clinic, https://pmc.ncbi.nlm.nih.gov/articles/PMC4708587/, https://pmc.ncbi.nlm.nih.gov/articles/PMC4029103/
Vasectomy		Increased	• Incidence	No	No	ACS, Cancer Research UK, https://pubmed.ncbi.nlm.nih.gov/31119294/, https://www.sciencedirect.com/science/article/pii/S2666168322005870
Diet and dietary supplements						

Prostate cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
Diet	Saturated fat, alpha-linolenic acid, eggs	Increased	• Incidence • Progression • Recurrence	No	No	ACS, NCI, Leitzmann, et al., Gann, et al., https://academic.oup.com/jnci/article/92/1/61/2905797, https://pmc.ncbi.nlm.nih.gov/articles/PMC3232297/
Diet	Fruit and vegetables, soy/legume products, coffee	Decreased	• Incidence • Mortality • Cancer sub-type	Yes (fruit and vegetables only)	Yes	ACS, NCI, Leitzmann, et al., Gann, et al., https://academic.oup.com/jnci/article/92/1/61/2905797, https://pmc.ncbi.nlm.nih.gov/articles/PMC3232297/
Cadmium exposure	Through tobacco smoking and certain foods	Increased	• Mortality • Disease severity • Cancer sub-type	No	No	Cancer Research UK, https://pubmed.ncbi.nlm.nih.gov/15945511/#full-view-affiliation-1, https://www.nature.com/articles/srep25814
Fish		Increased	• Mortality	No	No	Leitzmann, et al., https://pmc.ncbi.nlm.nih.gov/articles/PMC2843087/, https://pmc.ncbi.nlm.nih.gov/articles/PMC3629172/, https://ascopubs.org/doi/full/10.1200/JCO.24.00608
Red meat		Increased	• Incidence • Mortality • Disease severity	No	No	Leitzmann, et al., Gann, et al., https://pmc.ncbi.nlm.nih.gov/articles/PMC8859108/, https://pmc.ncbi.nlm.nih.gov/articles/PMC3232297/, https://academic.oup.com/aje/article/170/9/1165/165556, https://nutritionj.biomedcentral.com/articles/10.1186/s12937-015-0111-3
Dietary supplements	Specifically multi-vitamins, excessive use	Increased	• Incidence • Mortality	No	No	Leitzmann, et al., https://pmc.ncbi.nlm.nih.gov/articles/PMC9378679/, https://academic.oup.com/jnci/article/99/10/754/2522097, https://www.sciencedirect.com/science/article/pii/S002231662200493X, https://jamanetwork.com/journals/jama/fullarticle/1380451
Lycopene / Tomatoes		Increased	• Incidence • Progression	No	No	NCI, Gann, et al., https://pmc.ncbi.nlm.nih.gov/articles/PMC9741066/, https://pmc.ncbi.nlm.nih.gov/articles/PMC3742263/, https://www.health.harvard.edu/blog/lycopene-and-tomatoes-no-shield-against-prostate-cancer-20090403129
Hormones						
Insulin-like growth factor (IGF)-1		Increased	• Incidence	No	No	NCI, Cancer Research UK, Leitzmann, et al., Gann, et al. https://academic.oup.com/jnci/article/90/12/911/961570, https://bmccancer.biomedcentral.com/articles/10.1186/s12885-023-11425-w
Additional links to references included in table						
NCI: https://www.cancer.gov/types/prostate/patient/prostate-prevention-pdq, https://www.ncbi.nlm.nih.gov/books/NBK65968/ CDC: https://www.cdc.gov/prostate-cancer/risk-factors/index.html ACS: https://www.cancer.org/cancer/types/prostate-cancer/causes-risks-prevention/risk-factors.html Cancer Research UK: https://www.cancerresearchuk.org/about-cancer/prostate-cancer/risks-causes					

Prostate cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
John Hopkins: https://www.hopkinsmedicine.org/health/conditions-and-diseases/prostate-cancer/prostate-cancer-risk-factors Mayo Clinic: https://www.mayoclinic.org/diseases-conditions/prostate-cancer/symptoms-causes/syc-20353087 Cleveland Clinic: https://my.clevelandclinic.org/health/diseases/8634-prostate-cancer Leitzmann, et al. (2012): https://pubmed.ncbi.nlm.nih.gov/22291478/ Gann, et al. (2002): https://pubmed.ncbi.nlm.nih.gov/16986064/						

* Risk factor is outside the scope of this phase of the project and may be evaluated in a subsequent phase

Supplementary Table 2: Breast Cancer Risk Factors

Breast cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
Established associations (Evidence level HIGH): Consistent epidemiologic findings across a large number of well-designed studies. Shows a dose-response relationship, has a biologically possible mechanism, and has supportive laboratory evidence. *Risk factors specified as *relevant to premenopausal breast cancer* are not always mutually exclusive and may also be relevant to postmenopausal breast cancer. Premenopausal breast cancer has specific risk factors, which we try to distinguish here. Further, other risk factors not specifically designated as a premenopausal breast cancer risk factor could still be a contributor to disease.						
Demographics						
Age	• Younger age (20-49): Premenopausal cancers; typically the result of genetically driven disease • Older age: Postmenopausal cancers; typically the result of greater estrogen/hormonal influence	Increased	***Relevant to premenopausal breast cancer**** • Incidence • Mortality (specifically for very young or very old individuals) • Disease sub-type	Yes	All analyses are age-adjusted. Analyses are also separate for pre- and post-menopausal cancer.	NCI, ACS, CDC, https://pmc.ncbi.nlm.nih.gov/articles/PMC4491690/, https://pubmed.ncbi.nlm.nih.gov/29096890, https://www.sciencedirect.com/science/article/pii/S0960977621010122, https://www.bcrf.org/about-breast-cancer/breast-cancer-elderly/, https://pmc.ncbi.nlm.nih.gov/articles/PMC2626623/
Race and ethnicity	• Ashkenazi Jewish Heritage (more likely to have a BRCA mutation) • Black race • Minority women more likely to be diagnosed with	Increased	***Relevant to premenopausal breast cancer*** • Early onset (< age 45) • Incidence • Mortality	Yes	Yes	ACS, CDC, https://acsjournals.onlinelibrary.wiley.com/doi/full/10.1002/cncr.33846, https://pmc.ncbi.nlm.nih.gov/articles/PMC6941147/, https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-022-02260-0, https://www.nejm.org/doi/full/10.1056/NEJMp2200244, https://academic.oup.com/jnci/article/91/14/1241/2549286, https://jamanetwork.com/journals/jamaoncology/fullarticle/2644652, https://pmc.ncbi.nlm.nih.gov/articles/PMC5588632/

Breast cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
	early-onset and later-staged cancer		• Disease severity			
Genetics and family history						
Genetic mutations	BRCA1, BRCA2, other high-risk mutations	Increased	***Relevant to premenopausal breast cancer*** • Early onset incidence	No	No	NCI, ACS, CDC, https://academic.oup.com/jnci/article/91/14/1241/2549286, https://www.cancer.gov/about-cancer/causes-prevention/genetics/brca-fact-sheet, https://www.ncbi.nlm.nih.gov/books/NBK1247/, https://pubmed.ncbi.nlm.nih.gov/28632866/
History of breast cancer	Personal or familial (first-degree relative)	Increased	***Relevant to premenopausal breast cancer*** • Early onset incidence	No	No	NCI, ACS, https://www.nature.com/articles/s41598-021-85899-8, https://pubmed.ncbi.nlm.nih.gov/16034008/, https://pmc.ncbi.nlm.nih.gov/articles/PMC7973811/, https://pubmed.ncbi.nlm.nih.gov/28578505/
History of ovarian cancer	Personal or familial (first-degree relative)	Increased	***Relevant to premenopausal breast cancer*** • Early onset incidence	No	No	CDC, https://pmc.ncbi.nlm.nih.gov/articles/PMC7973811, https://pubmed.ncbi.nlm.nih.gov/30207593/
Reproductive history resulting in greater estrogen exposure						
Older age at first childbirth	Especially after age 30	Increased	***Relevant to premenopausal breast cancer*** • Incidence	Yes	Yes	NCI, ACS, CDC, https://pubmed.ncbi.nlm.nih.gov/5312521/, https://pubmed.ncbi.nlm.nih.gov/8202106/, https://pubmed.ncbi.nlm.nih.gov/8178795/, https://pubmed.ncbi.nlm.nih.gov/11092437/, https://pubmed.ncbi.nlm.nih.gov/28637226/, https://pubmed.ncbi.nlm.nih.gov/5312521/, https://pubmed.ncbi.nlm.nih.gov/8202106/, https://pubmed.ncbi.nlm.nih.gov/8178795/, https://pubmed.ncbi.nlm.nih.gov/11092437/, https://pubmed.ncbi.nlm.nih.gov/28637226/

Breast cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
No children / parity	The result of longer exposure to estrogen (estrogen production decreases during pregnancy)	Increased	***Relevant to premenopausal breast cancer*** • Incidence	No	No	NCI, ACS, CDC, https://pubmed.ncbi.nlm.nih.gov/8178795/, https://pubmed.ncbi.nlm.nih.gov/11092437/, https://pubmed.ncbi.nlm.nih.gov/28637226/
Number of births	Risk decreases with more births	Decreased	• Incidence	No	No	https://onlinelibrary.wiley.com/doi/full/10.1002/ijc.32923, https://pubmed.ncbi.nlm.nih.gov/5312521/, https://pubmed.ncbi.nlm.nih.gov/8202106/, https://pubmed.ncbi.nlm.nih.gov/8178795/, https://pubmed.ncbi.nlm.nih.gov/11092437/, https://pubmed.ncbi.nlm.nih.gov/28637226/, https://pubmed.ncbi.nlm.nih.gov/5312521/, https://pubmed.ncbi.nlm.nih.gov/8202106/, https://pubmed.ncbi.nlm.nih.gov/8178795/, https://pubmed.ncbi.nlm.nih.gov/11092437/, https://pubmed.ncbi.nlm.nih.gov/28637226/
Age at first menarche	Younger age at first menarche = longer exposure to estrogen	Increased	***Relevant to premenopausal breast cancer*** • Incidence	No	No	NCI, ACS, CDC, https://breast-cancer-research.biomedcentral.com/articles/10.1186/s13058-020-01326-2, https://pubmed.ncbi.nlm.nih.gov/33820799/, https://pmc.ncbi.nlm.nih.gov/articles/PMC3488186/, https://pmc.ncbi.nlm.nih.gov/articles/PMC3978643/
Age at menopause	Older age at menopause = longer exposure to estrogen	Increased	• Incidence	No	No	NCI, ACS, CDC, https://pmc.ncbi.nlm.nih.gov/articles/PMC3488186/, https://www.komen.org/breast-cancer/facts-statistics/research-studies/topics/age-at-menopause-and-breast-cancer-risk/, https://aacrjournals.org/cebp/article/16/4/740/277120/Age-at-Menarche-and-Menopause-and-Breast-Cancer
Breastfeeding	Less exposure to estrogen (estrogen production decreases during pregnancy and breastfeeding)	Decreased	***Relevant to premenopausal breast cancer*** • Incidence	No	No	NCI, ACS, https://pubmed.ncbi.nlm.nih.gov/32064598/, https://pubmed.ncbi.nlm.nih.gov/28637226/, https://pubmed.ncbi.nlm.nih.gov/12133652/, https://pubmed.ncbi.nlm.nih.gov/16859501/
Hormone replacement therapy (HRT)	Given for symptoms of menopause; especially relevant to estrogen + progestin combination HRT	Increased	• Incidence	No	No	NCI, ACS, CDC, https://pubmed.ncbi.nlm.nih.gov/40609572/, https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(19)31709-X/fulltext, https://www.nature.com/articles/s41416-024-02590-1

Breast cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
Lifestyle / behavioral / modifiable risk factors						
Alcohol		Increased	***Relevant to premenopausal breast cancer*** • Incidence	Yes	Yes	NCI, ACS, CDC, https://pubmed.ncbi.nlm.nih.gov/25422909/, https://pubmed.ncbi.nlm.nih.gov/38514233/, https://pubmed.ncbi.nlm.nih.gov/39581746/, https://pubmed.ncbi.nlm.nih.gov/12439712/
Smoking		Increased	***Relevant to premenopausal breast cancer*** • Incidence • Mortality	Yes	Yes	CDC, ACS
Weight gain	Especially post-menopause	Increased	***Relevant to premenopausal breast cancer*** • Incidence	No	No	CDC, ACS
Body weight	Especially in post-menopausal women who have not used hormone therapy, and gained weight after menopause	Increased	***Relevant to premenopausal breast cancer*** • Incidence	Yes	Yes	NCI, ACS, CDC, https://pmc.ncbi.nlm.nih.gov/articles/PMC10373406/, https://www.komen.org/breast-cancer/facts-statistics/research-studies/topics/weight-gain-and-the-risk-of-breast-cancer/, https://pmc.ncbi.nlm.nih.gov/articles/PMC5591063/, https://pubmed.ncbi.nlm.nih.gov/18280327/, https://pubmed.ncbi.nlm.nih.gov/24375928/
Anatomy / health conditions						
High breast density		Increased	***Relevant to premenopausal breast cancer*** • Incidence	No	No	NCI, ACS, https://pmc.ncbi.nlm.nih.gov/articles/PMC10091988/, https://www.nature.com/articles/s41598-025-09315-1, https://pubmed.ncbi.nlm.nih.gov/36183671/, https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2783508
Hyperplasia / benign breast conditions	Lobular carcinoma *in situ* (LCIS), ductal carcinoma *in situ* (DCIS), atypical ductal hyperplasia, or	Increased	***Relevant to pre-menopausal breast cancer*** • Incidence	No	No	NCI, ACS, https://jamanetwork.com/journals/jamasurgery/fullarticle/2813028, https://pubmed.ncbi.nlm.nih.gov/16034008/, https://pubmed.ncbi.nlm.nih.gov/25636589/

Breast cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
	atypical lobular hyperplasia					
Personal history of cancer	Biological and genetic factors that predisposed a person to the first cancer may still be present, increasing the likelihood of a new tumor in the other breast or a different part of the same breast. This risk applies to a second primary breast cancer, which is a new and unrelated cancer, rather than a recurrence of the original tumor.	Increased	***Relevant to premenopausal breast cancer*** • Incidence	No	No	NCI, ACS, CDC, https://pubmed.ncbi.nlm.nih.gov/24450667/, https://ajronline.org/doi/10.2214/AJR.13.11553
Risk-reducing prophylactic mastectomy	Risk reduction for BRCA1/BRCA2 genetic mutation	Decreased	• Incidence	No	No	NCI, https://www.cancer.gov/types/breast/risk-reducing-surgery-fact-sheet, https://pmc.ncbi.nlm.nih.gov/articles/PMC6057165/, https://ascopubs.org/doi/10.1200/JCO.2004.04.188
Ovarian ablation	The removal of ovaries following an ovarian cancer diagnosis	Decreased	***Relevant to premenopausal breast cancer*** • Incidence	No	No	NCI, https://ascopubs.org/doi/10.1200/JCO.2023.41.16_suppl.503
Probable associations (Evidence level MODERATE): Epidemiological evidence is largely consistent but is not as extensive as the established associations to draw a solid conclusion.						
Reproductive history resulting in greater estrogen exposure						

Breast cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
Birth control pills	Current or recent use. Per ACS: Risk is elevated when taking hormonal contraceptives, however, risk diminishes after 10 years of stopping	Increased	• Incidence	No	No	NCI, ACS, CDC
Early thelarche	Reproductive history resulting in greater estrogen exposure; signifies a prolonged period of breast cell proliferation susceptible to hormonal influences	Increased	• Incidence	No	No	https://breast-cancer-research.biomedcentral.com/articles/10.1186/s13058-020-01326-2, https://pmc.ncbi.nlm.nih.gov/articles/PMC3978643/
Hormones						
AMH	Elevated levels	Increased	• Incidence	No	No	Susan G. Komen
IGF-1	Elevated levels	Increased	• Incidence	No	No	Susan G. Komen
Blood androgen	Elevated levels	Increased	• Incidence	No	No	Susan G. Komen
Blood estrogen	Elevated levels *after* menopause	Increased	• Incidence	No	No	Susan G. Komen
Prolactin	Elevated levels	Increased	• Incidence	No	No	Susan G. Komen
Anatomy						
High bone density		Increased	• Incidence	No	No	Susan G. Komen
Larger birthweight		Increased	• Incidence	No	No	Susan G. Komen
Taller height	Especially related to how long it took to reach adult height (could signify higher	Increased	• Incidence	No	No	ACS, https://pmc.ncbi.nlm.nih.gov/articles/PMC3978643/

Breast cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
	levels growth hormones during puberty)					
Lifestyle / behavior / modifiable risk factors						
Sedentary behavior	Especially for post-menopausal and obese women; prevalent in obese women with breast cancer	Increased	• Incidence	Yes	No	CDC, https://pmc.ncbi.nlm.nih.gov/articles/PMC8221371/, https://link.springer.com/article/10.1007/s10552-019-01223-w
Exercise / physical activity	Pathway is unclear--likely due to the effects of physical activity on body weight, inflammation, and hormone levels	Decreased	• Incidence	Yes	Yes	NCI, ACS, https://pubmed.ncbi.nlm.nih.gov/20975025/, https://pubmed.ncbi.nlm.nih.gov/26687833/, https://pubmed.ncbi.nlm.nih.gov/29223719/, https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2798622
Fruit and vegetable consumption		Decreased	• Incidence	Yes	Yes	ACS, CDC
Night shift work	Prolonged nighttime light exposure; alteration to melatonin and other hormonal fluctuations	Increased	• Incidence	No	No	CDC, ACS
Carotenoids	(Consumption of)	Decreased	• Incidence	No	No	Susan G. Komen
Radiation exposure						
Radiation therapy to the breast or chest	Especially during early childhood or early adulthood	Increased	***Relevant to pre-menopausal breast cancer*** • Incidence	No	No	NCI, ACS, https://pmc.ncbi.nlm.nih.gov/articles/PMC4100937/, https://bmccancer.biomedcentral.com/articles/10.1186/1471-2407-12-197, https://pubmed.ncbi.nlm.nih.gov/24752044/, https://pubmed.ncbi.nlm.nih.gov/26972653/, https://jamanetwork.com/journals/jamapediatrics/fullarticle/2753619
Possible associations (Evidence level LIMITED): Recognized as potentially linked (or not linked in some cases) to breast cancer. More study is needed before solid conclusions can be made. Epidemiologic findings are supportive but limited in quantity or quality. Results are generally consistent, but only						

Breast cancer risk factor	Notes / considerations	Direction of risk	Type of risk	Data available for this project	Variable used in analysis	References
hint at a possible relationship. Supportive laboratory evidence may or may not be available. May not be a clear biological reason the factor might be linked to risk. These factors are still under study.						
Hormones						
Insulin	Elevated levels *after* menopause	Increased	• Incidence	No	No	Susan G. Komen
Blood estrogen	Elevated levels *before* menopause	Increased	• Incidence	No	No	Susan G. Komen
Anatomy / health conditions						
Diabetes	Onset *after* menopause	Increased	• Incidence	Yes	No	ACS, CDC
Lifestyle / behavioral / modifiable factors						
Meat consumption		Increased	• Incidence	No	No	Susan G. Komen
Vitamin D	Deficiency increases risk	Decreased	• Incidence • Progression	Limited	No	Susan G. Komen
Additional links to references included in table						
NCI: https://www.cancer.gov/types/breast/causes-risk-factors, https://www.cancer.gov/types/breast/hp/breast-prevention-pdq CDC: https://www.cdc.gov/breast-cancer/risk-factors/index.html, https://www.cdc.gov/bring-your-brave/risk-factors/index.html ACS: https://www.cancer.org/cancer/types/breast-cancer/risk-and-prevention.html Susan G. Komen: https://www.komen.org/breast-cancer/risk-factor/						