# Breast Cancer Data Analysis

### Jagadish Rao

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#### Introduction

This analysis project is the culmination and final requirement of the **Google Data Analytics Professional Certificate**. It aims to utilize the learning and best practices taught in the course. A sincere 'Thank You' to all my instructors, it was a great, well designed course.

Cancer needs no introduction as a disease that inflicts its pain, suffering, leading to disfigurement and eventual death if not detected and treated early. Unfortunately, the early signs and symptoms of the disease and its progress are often neglected, missed or masked by other diseases. Female breast cancer is a silent killer that can strike anytime, so knowing and proactively acting on the disease patterns is critical.

The identification of breast cancer trends in the USA has been selected for this project. This analysis is approached from a data analytics perspective and has no claims to being a substitute or auxiliary to a professional medical study or advice.

### **Analysis Objectives**

There are many open questions that this analysis seeks to answer:

- Does cancer rate vary by geographical location
- Does race play a part
- Does increasing age lead to a higher risk
- Is there a relationship between race and age as related to cancer risk

#### Raw Data

United States Cancer Statistics - Incidence: 1999 - 2018, WONDER Online Database. United States Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute; 2021.

Dataset: United States and Puerto Rico Cancer Statistics, 1999-2018 Incidence

https://wonder.cdc.gov/cancer-v2018.HTML

#### Query Parameters:

Age Groups: 10-14 years; 15-19 years; 20-24 years; 25-29 years; 30-34 years; 35-39 years; 40-44 years; 45-49 years; 50-54 years; 55-59 years; 60-64 years; 65-69 years; 70-74 years; 75-79 years; 80-84 years; 85+ years Cancer Sites: Female Breast

Race: American Indian or Alaska Native; Asian or Pacific Islander; Black or African American; White Sex: Female

States: Alabama (01); Alaska (02); Arizona (04); Arkansas (05); California (06); Colorado (08); Connecticut (09); Delaware (10); District of Columbia (11); Florida (12); Georgia (13); Hawaii (15); Idaho (16); Illinois (17); Indiana (18); Iowa (19); Kansas (20); Kentucky (21); Louisiana (22); Maine (23); Maryland (24); Massachusetts (25); Michigan (26); Minnesota (27); Mississippi (28); Missouri (29); Montana (30); Nebraska (31); Nevada (32); New Hampshire (33); New Jersey (34); New Mexico (35); New York (36); North Carolina (37); North Dakota (38); Ohio (39); Oklahoma (40); Oregon (41); Pennsylvania (42); Rhode Island (44);

South Carolina (45); South Dakota (46); Tennessee (47); Texas (48); Utah (49); Vermont (50); Virginia (51); Washington (53); West Virginia (54); Wisconsin (55); Wyoming (56)

Group By: Cancer Sites; States; Year; Race; Age Groups

Calculate Rates Per: 100,000

Standard Population: 2000 U.S. Std. Million

Cancer incidence (rate) data is standardized to a population of 100k.

Data is not available if the rate is less than 16.

The raw data was downloaded in four separate text data files due to CDC site download size restrictions. The downloaded files were then renamed to more user friendly titles.

- $\bullet$  breast cancer 2000 2004.txt
- breast cancer 2005 2009.txt
- $\bullet \hspace{0.2cm} breast\_cancer\_2010\_2013.txt$
- $\bullet \hspace{0.2cm} breast\_cancer\_2014\_2018.txt$

#### Tools

Language: R

 $Environment: RStudio\ 2021.09.1+372\ "Ghost\ Orchid"\ Release\ (8b9ced188245155642d024aa3630363df611088a, 2021-11-08)\ for\ macOS$ 

#### **Data Organization**

The downloaded raw data files are tab delimited text files with Header.

The four raw data files are located in a sub folder named "data".

#### **Processing and Analysis**

```
library(tidyverse)
library(here)
library(janitor)
library(skimr)
library(validate)
library(usmap)
```

#### R packages Load

```
bcdata_2000_2004 <- read.delim(here("data", "breast_cancer_2000_2004.txt"))
bcdata_2005_2009 <- read.delim(here("data", "breast_cancer_2005_2009.txt"))
bcdata_2010_2013 <- read.delim(here("data", "breast_cancer_2010_2013.txt"))
bcdata_2014_2018 <- read.delim(here("data", "breast_cancer_2014_2018.txt"))</pre>
```

#### Raw data Read

```
bcdata <- bind_rows(bcdata_2000_2004, bcdata_2005_2009, bcdata_2010_2013, bcdata_2014_2018)
```

#### Raw data Merge

```
bcdata <- clean_names(bcdata)</pre>
```

#### Column names to lowercase

```
bcdata <- bcdata %>%
select(states, year, race, age_groups_code, count)
```

#### Columns selection for analysis

```
bcdata <- bcdata %>%
  rename(state = states, age_grp = age_groups_code, count_100k = count)
```

Columns rename for clarity At this point, all the data has been loaded, relevant columns selected and renamed.

skim(bcdata)

#### **Data Checking**

Table 1: Data summary

Name	bcdata
Number of rows	18745
Number of columns	5
Column type frequency:	
character	3
numeric	2
Group variables	None

#### Variable type: character

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
state	0	1	0	20	280	52	0
race	0	1	0	32	280	5	0
$age\_grp$	0	1	0	5	280	15	0

#### Variable type: numeric

skim_variable n_ii	nissing complete	_rate mean	sd	p0	p25	p50	p75	p100	hist
year count 100k	280 280	0.99 2009.32 0.99 220.95		2000 16	2005 42	2009 102	2014 258	2018 3102	

tabyl(bcdata, state, year)

state 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

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## ##	Alabama	0 23	0 24	0 23	0 24	0 24	0 23	0 24	0 23	0 24	0 23	0 23
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##	Alaska	12	13	5 12	12	12	8 13	12	13			8 17
## ##	Arizona	0	17	19	18	18	18	16	18	15 18	13 18	20
##	Arkansas California	38	37	37	40	38	37	38	41	40	40	41
##	California	12	12	13	12	30 12	12	12	14	13	16	15
##	Connecticut	14	17	19	17	17	18	18	18	18	19	17
##	Delaware	14	10	19	11	13	12	11	13	13	13	13
##	District of Columbia	16	12	14	15	11	11	12	12	13	15 15	12
##	Florida	27	27	27	25	29	26	28	30	31	30	32
##	Georgia	25	24	25	25	26	25	26	27	27	27	29
##	Hawaii	17	19	20	20	19	18	18	19	20	19	18
##	Idaho	11	11	11	11	11	11	11	11	11	11	11
##	Illinois	25	25	25	25	25	25	25	25	25	25	25
##	Indiana	18	22	21	22	21	22	20	22	21	20	20
##	Indiana	12	12	12	12	12	12	12	12	12	12	12
##	Kansas	11	11	12	12	12	12	12	12	12	12	13
##	Kentucky	18	18	19	17	17	19	19	18	21	18	19
##	Louisiana	22	23	24	24	24	24	24	23	23	24	23
##	Maine	11	11	12	11	11	11	11	11	10	11	11
##	Maryland	25	26	25	24	24	26	24	27	29	28	29
##	Massachusetts	16	14	20	18	18	22	18	23	24	22	24
##	Michigan	24	25	25	25	25	25	24	25	25	23	24
##	Minnesota	12	12	12	12	12	12	12	12	12	12	12
##	Mississippi	0	0	0	22	22	23	22	22	23	22	23
##	Missouri	21	22	23	22	23	23	22	24	24	23	22
##	Montana	11	10	10	11	10	10	11	10	11	11	11
##	Nebraska	11	11	11	11	11	11	11	12	11	12	11
##	Nevada	11	12	11	11	13	12	15	16	13	18	18
##	New Hampshire	11	11	11	11	11	11	11	11	11	11	11
##	New Jersey	30	30	29	31	33	30	32	32	34	33	32
##	New Mexico	11	11	11	11	11	11	11	12	11	12	11
##	New York	33	35	35	36	36	35	35	36	34	35	37
##	North Carolina	25	25	25	25	25	25	25	25	25	26	25
##	North Dakota	10	9	10	10	10	10	10	10	10	10	10
##	Ohio	25	25	25	24	24	25	24	24	24	24	25
##	Oklahoma	18	20	22	24	21	21	23	22	26	25	23
##	Oregon	12	12	12	12	12	12	12	12	12	12	12
##	Pennsylvania	25	26	24	24	26	25	26	26	26	26	26
##	Rhode Island	11	11	11	11	11	10	11	11	11	10	11
##	South Carolina	24	24	23	24	24	24	24	23	24	24	24
##	South Dakota	0	11	10	10	10	10	10	10	11	11	10
##	Tennessee	23	22	22	24	25	23	25	24	23	24	23
##	Texas	30	30	30	31	33	31	33	33	33	33	36
##	Utah	11	12	11	11	12	11	12	12	12	12	12
##	Vermont	10	11	10	10	11	10	11	10	10	10	10
##	Virginia	26	26	26	26	30	27	28	28	29	29	29
##	Washington	15	17	19	18	19	20	20	20	23	20	22
##	West Virginia	12	11	12	11	11	11	11	11	12	11	11
##	Wisconsin	13	14	14	16	14	15	16	15	16	19	18
##	Wyoming	10	10	10	9 210 M	9	9	9	9	10	8	8
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```

tabyl(bcdata, state, age\_grp)

##

state 20-24 25-29 30-34 35-39 40-44 45-49 50-54 55-59 60-64

##		0	0	0	0	0	0	0	0	0
##	Alabama	0	2	31	38	38	38	38	38	38
##	Alaska	0	0	0	0	16	19	20	19	20
##	Arizona	0	6	19	19	22	31	29	29	33
##	Arkansas	0	0	15	20	34	36	36	35	35
##	California	5	32	57	57	57	60	65	66	66
##	Colorado	0	8	19	19	19	26	26	26	24
##	Connecticut	0	0	19	19	33	39	36	37	37
##	Delaware	0	0	0	6	20	27	32	28	29
##	District of Columbia	0	0	0	0	17	26	32	31	33
##	Florida	0	30	38	42	48	52	54	55	48
##	Georgia	0	22	38	39	46	48	50	46	46
##	Hawaii	0	0	0	16	28	38	38	38	38
##	Idaho	0	0	3	19	19	19	19	19	19
##	Illinois	0	20	38	38	38	38	38	38	38
##	Indiana	0	7	19	22	37	38	38	38	38
##	Iowa	0	0	19	19	19	19	19	19	19
##	Kansas	0	0	17	19	19	21	20	22	21
##	Kentucky	0	3	19	19	27	38	38	38	35
##	Louisiana	0	1	30	38	38	38	38	38	38
##	Maine	0	0	1	17	19	19	19	19	19
##	Maryland	0	2	35	41	49	51	52	52	48
##	Massachusetts	0	8	19	29	43	51	50	48	45
##	Michigan	0	17	32	38	40	45	43	40	42
##	Minnesota	0	6	19	19	23	24	25	24	24
##	Mississippi	0	0	6	32	32	32	32	32	32
##	Missouri	0	6	20	33	38	38	38	38	38
##	Montana	0	0	0	10	19	19	19	19	19
##	Nebraska	0	0	7	19	19	19	19	19	19
##	Nevada	0	0	12	18	19	29	32	33	33
##	New Hampshire	0	0	0	19	19	19	19	19	19
##	New Jersey	0	15	32	53	57	57	57	57	57
##	New Mexico	0	0	5	19	19	19	19	20	19
##	New York	0	29	54	57	57	57	57	57	57
##	North Carolina	0	21	38	38	41	42	43	39	41
##	North Dakota	0	0	0	0	16	19	19	19	19
##	Ohio	0	19	28	38	39	41	40	38	40
##	Oklahoma	0	0	19	19	32	45	52	55	53
##	Oregon	0	1	19	19	20	22	22	21	20
##	Pennsylvania	0	19	31	38	46	50	47	46	43
##	Rhode Island	0	0	0	15	19	19	19	19	19
##	South Carolina	0	1	34	38	38	38	38	38	38
##	South Dakota	0	0	0	6	18	18	18	18	18
##	Tennessee	0	8	26	38	38	38	38	38	38
##	Texas	1	29	43	55	57	57	57	58	55
##	Utah	0	1	15	19	19	19	19	19	19
##	Vermont	0	0	0	3	19	19	19	19	19
##	Virginia	0	9	36	41	52	55	55	54	51
##	Washington	0	9	19	26	38	47	47	47	45
##	West Virginia	0	0	4	19	19	19	19	19	19
##	Wisconsin	0	4	19	20	26	36	36	34	34
##	Wyoming	0	0	0	0	15	19	19	19	19
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##	28	20	19	19	19	0
##	32	31	23	19	21	0
##	64	62	57	57	57	0
##	23	19	19	19	19	0
##	34	30	27	19	19	0
##	25	23	19	19	19	0
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##	51	46	41	38	38	0
##	43	40	39	38	38	0
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##	32	32	32	32	32	0
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##	52	51	47	39	38	0
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##	57	57	54	49	44	0
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tabyl(bcdata, state, race)

##

state American Indian or Alaska Native

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                                                              0
##
                Tennessee
                                                              0
##
                     Texas
                                                              4
                      Utah
                                                              0
##
##
                   Vermont
                                                              0
##
                 Virginia
                                                              0
##
                                                              5
               Washington
##
            West Virginia
                                                              0
##
                Wisconsin
                                                              0
                   Wyoming
##
##
    Asian or Pacific Islander Black or African American White emptystring_
##
                                                                  0
                                                                               280
```

## 14	##	0	221	230	0
## 239 230 252 0 ## 239 230 252 0 ## 7 23 236 0 ## 22 119 228 0 ## 0 51 196 0 ## 0 172 77 0 ## 95 239 247 0 ## 205 0 154 0 ## 0 0 238 0 ## 205 0 154 0 ## 0 0 212 0 ## 0 0 212 0 ## 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 229 247 0 ## 1 0 0 228 0 ## 1 0 0 228 0 ## 1 0 0 228 0 ## 1 0 0 228 0 ## 1 0 0 221 226 0 ## 1 0 0 221 228 0 ## 1 0 0 0 221 228 0 ## 1 0 0 0 221 228 0 ## 1 0 0 0 208 0 ## 25 222 245 0 ## 3 22 234 0 ## 1 0 181 177 0 ## 1 0 198 234 0 ## 1 0 198 234 0 ## 1 0 0 198 234 0 ## 1 0 0 0 126 0 ## 1 147 222 243 0 ## 1 147 222 243 0 ## 1 147 222 243 0 ## 1 149 222 243 0 ## 1 0 0 0 187 0 ## 1 0 0 0 187 0 ## 1 0 0 0 187 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 0 ## 1 0 0 0 0 ## 1 0 0 0 0 ## 1 0 0 0 0 ## 1 0 0 0 0 ## 1 0 0 0 0 ## 1 0 0 0 0 ## 1 0 0 0 0 ## 1 0 0 0 0 ## 1	##	0	0	143	0
## 239 230 252 0 ## 7 23 236 0 ## 22 119 228 0 ## 90 51 196 0 ## 95 239 247 0 ## 95 239 247 0 ## 10 172 77 0 ## 10 212 77 0 ## 10 212 77 0 ## 10 212 77 0 ## 10 212 77 0 ## 10 212 77 0 ## 10 212 77 0 ## 10 228 0 ## 10 229 247 0 ## 10 229 247 0 ## 10 229 247 0 ## 10 229 247 0 ## 10 228 0 ## 177 225 231 0 ## 177 225 230 0 ## 177 225 230 0 ## 177 0 ## 18 177 0 ## 19 218 234 0 ## 10 0 181 177 0 ## 10 0 198 234 0 ## 147 222 243 0 ## 147 222 243 0 ## 148 0 0 0 181 177 0 ## 149 220 243 0 ## 149 221 247 0 ## 149 228 248 0 ## 149 221 247 0 ## 149 228 248 0 ## 149 221 247 0 ## 149 228 248 0 ## 149 221 247 0 ## 149 228 248 0 ## 149 221 247 0 ## 149 228 248 0 ## 149 228 248 0 ## 149 228 248 0 ## 149 228 248 0 ## 149 238 248 0 ## 149 248 248 0 ## 149 248 248 0	##	14	38	234	0
## 7 23 236 0 0   ## 22 119 228 0 0   ## 0 51 196 0   ## 0 172 77 0 0   ## 55 239 247 0 0   ## 55 239 247 0 0   ## 205 0 154 0 238 0 0   ## 0 0 212 0 0   ## 0 0 229 247 0 0   ## 0 0 229 247 0 0   ## 0 0 229 247 0 0   ## 0 0 229 247 0 0   ## 0 0 169 235 0 0   ## 0 0 122 226 0 0   ## 0 0 12 226 0 0   ## 0 0 12 226 0 0   ## 0 0 12 226 0 0   ## 0 0 125 231 0 0   ## 0 0 125 231 0 0   ## 0 0 0 221 228 0 0   ## 77 225 230 0 0   ## 67 135 236 0 0   ## 3 3 22 234 0 0   ## 3 3 22 234 0 0   ## 3 3 22 234 0 0   ## 0 181 177 0 0   ## 0 188 234 0 0   ## 0 0 0 216 0 0   ## 0 0 0 216 0 0   ## 0 0 0 216 0 0   ## 0 0 0 216 0 0   ## 147 222 243 0 0   ## 147 222 243 0 0   ## 147 222 243 0 0   ## 147 222 243 0 0   ## 149 221 238 247 0 0   ## 149 221 247 0 0   ## 149 222 243 0 0   ## 149 221 247 0 0   ## 149 221 247 0 0   ## 149 238 248 0 0   ## 149 221 247 0 0   ## 149 221 247 0 0   ## 149 238 248 0 0   ## 149 249 249 249 249 0 0   ## 149 249 249 249 0 0   ## 149 249 249 249 0 0   ## 149 249 249 249 0 0   ## 149 249 249 24	##	0	124	213	0
## 2 119 228 0 0	##	239	230	252	0
## 0 51 196 0 0 ## 196 0 ## 195 239 247 0 172 77 0 0 184 195 239 247 0 184 195 240 238 0 0 184 195 240 238 0 0 184 195 240 238 0 0 184 195 240 238 0 0 184 195 240 238 0 0 184 195 240 238 0 0 184 195 240 238 0 0 184 195 240 238 0 0 184 195 240 238 0 0 184 195 240 238 0 0 185 235 0 0 184 195 240 240 240 240 240 240 240 240 240 240	##	7	23	236	0
## 95 239 247 0  ## 95 239 247 0  ## 55 240 238 0  ## 205 0 154 0  ## 0 205 212 20  ## 0 229 247 0  ## 0 229 247 0  ## 0 169 235 0  ## 0 122 226 0  ## 0 122 226 0  ## 0 122 226 0  ## 0 122 231 0  ## 0 221 228 0  ## 0 221 228 0  ## 0 221 228 0  ## 0 20 221 228 0  ## 0 20 221 228 0  ## 0 0 221 228 0  ## 0 0 12 26 33 0  ## 77 225 230 0  ## 67 135 236 0  ## 25 222 245 0  ## 3 22 244 0  ## 10 198 234 0  ## 0 198 234 0  ## 0 198 234 0  ## 0 198 234 0  ## 0 198 234 0  ## 10 0 0 198 234 0  ## 10 0 0 200 0  ## 14 147 222 243 0  ## 147 222 243 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 229 0  ## 10 0 0 214 0  ## 10 0 0 214 0  ## 10 0 0 229 0  ## 10 0 0 216 0  ## 10 0 0 216 0  ## 10 0 0 216 0  ## 10 0 0 214 0  ## 10 0 0 225 0  ## 10 0 0 186 0  ## 10 0 0 193 0  ## 149 238 248 0  ## 149 238 248 0  ## 149 238 248 0  ## 149 238 248 0  ## 149 338 247 0  ## 149 338 247 0  ## 149 338 247 0  ## 149 328 248 0  ## 149 328 2	##	2	119	228	0
## 95 247 0 ## 55 240 238 0 ## 205 0 154 0 ## 0 212 0 ## 0 229 247 0 ## 0 229 247 0 ## 0 168 235 0 ## 0 0 229 247 0 ## 0 0 229 247 0 ## 0 0 229 247 0 ## 0 0 229 247 0 ## 0 0 229 247 0 ## 0 0 228 0 ## 0 0 228 0 ## 0 122 226 0 ## 0 221 228 0 ## 0 221 228 0 ## 0 221 228 0 ## 0 221 228 0 ## 0 208 0 ## 77 225 230 0 ## 67 135 236 0 ## 25 222 245 0 ## 3 222 245 0 ## 3 3 22 234 0 ## 0 181 177 0 ## 0 181 177 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 200 0 ## 0 0 0 0 0 ## 0 0 0 0 0 0 ## 0 0 0 0	##	0	51	196	0
## 55	##	0	172	77	0
## 205 0 154 0 154	##	95	239	247	0
## 0 0 10 212 0 0 ## 0 229 247 0 1	##	55	240	238	0
## 0 229 247 0 ## 0 169 235 0 ## 0 0 228 0 ## 0 12 226 0 ## 0 12 226 0 ## 0 221 228 0 ## 0 221 228 0 ## 77 225 230 0 ## 67 135 236 0 ## 25 222 245 0 ## 0 181 177 0 ## 0 181 177 0 ## 0 198 234 0 ## 0 0 200 0 ## 0 0 200 0 ## 10 0 200 0 ## 0 0 200 0 ## 10 0 200 0 ## 20 0 20 0	##	205	0	154	0
## 0 169 235 0 ## 0 0 228 0 ## 0 12 228 0 ## 0 12 228 0 ## 0 125 231 0 ## 0 221 228 0 ## 0 221 228 0 ## 0 208 0 ## 77 225 230 0 ## 67 135 236 0 ## 33 22 245 0 ## 0 181 7 0 ## 0 181 7 0 ## 0 198 234 0 ## 0 0 200 0 ## 0 186 0 ## 0 201 0 ## 0 202 0 ## 0 205 0 ## 0 204 229 0 ## 0 205 0 ## 0 205 0 ## 0 205 0 ## 0 205 0 ## 0 205 0 ## 0 205 0 ## 0 206 0 ## 0 205 0 ##	##	0	0	212	0
## 0 0 128 0 0 4 28 0 0 ## 10 12 226 0 0 125 231 0 0 125 231 0 0 125 231 0 0 125 231 0 0 125 231 0 0 221 228 0 0 144 0 0 221 228 0 0 144 0 0 158 177 0 158 1	##	0	229	247	0
## 0 125 231 0 ## 0 221 228 0 ## 0 221 228 0 ## 77 225 230 0 ## 77 225 230 0 ## 25 222 245 0 ## 3 22 245 0 ## 0 181 177 0 ## 0 181 177 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 216 0 ## 0 0 216 0 ## 0 0 216 0 ## 0 0 209 0 ## 147 222 243 0 ## 0 0 0 214 0 ## 0 0 0 187 0 ## 10 0 0 187 0 ## 10 0 0 187 0 ## 10 0 0 229 0 ## 10 0 0 229 0 ## 10 0 0 187 0 ## 10 0 0 229 0 ## 10 0 0 187 0 ## 10 0 0 229 0 ## 10 0 0 186 0 ## 149 221 247 0 ## 0 0 0 186 0 ## 149 238 248 0 ## 149 249 259 0 ## 149 259 0 ## 150 0	##	0	169	235	0
## 0 125 231 0 ## 0 221 228 0 ## 0 221 228 0 ## 77 225 230 0 ## 67 135 236 0 ## 25 222 245 0 ## 0 181 177 0 ## 0 181 177 0 ## 0 181 177 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 200 0 ## 0 0 216 0 ## 0 0 200 0 ## 0 0 216 0 ## 0 0 187 220 243 0 ## 0 0 181 0 ## 0 0 0 187 0 ## 0 0 187 0 ## 0 0 187 0 ## 0 0 187 0 ## 0 0 0 187 0 ## 0 0 0 187 0 ## 0 0 0 0 187 0 ## 0 0 0 0 0 ## 0 0 0 0 0 ## 0 0 0 0	##	0	0	228	0
## 0 221 228 0 ## 77 225 230 0 ## 67 135 236 0 ## 25 222 245 0 ## 3 22 234 0 ## 0 181 177 0 ## 0 198 234 0 ## 0 198 234 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 200 0 ## 0 0 187 0 ## 147 222 243 0 ## 201 238 247 0 ## 16 230 247 0 ## 16 230 247 0 ## 1 0 0 187 0 ## 1 0 0 209 0 ## 1 0 0 209 0 ## 1 0 0 187 0 ## 1 0 0 209 0 ## 1 0 0 187 0 ## 1 0 0 209 0 ## 1 0 0 187 0 ## 1 0 0 209 0 ## 1 0 0 187 0 ## 1 0 0 209 0 ## 1 0 0 187 0 ## 1 0 0 205 0 ## 200 0 205 0 ## 20	##	0	12	226	0
## 77	##	0	125	231	0
## 777	##	0	221	228	0
## 67 135 236 0 ## 25 222 245 0 ## 3 22 234 0 ## 0 181 177 0 ## 0 198 234 0 ## 0 0 200 0 ## 0 0 216 0 ## 40 35 210 0 ## 0 0 209 0 ## 147 222 243 0 ## 201 238 247 0 ## 201 238 247 0 ## 16 230 247 0 ## 9 218 247 0 ## 9 218 247 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 187 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 187 0 ## 10 0 224 229 0 ## 10 0 225 0 ## 149 238 248 0 ## 157 257 0 ## 1	##	0	0	208	0
## 25 22 245 0 ## 3 22 234 0 ## 0 181 177 0 ## 0 198 234 0 ## 0 0 200 0 ## 0 0 200 0 ## 4 0 0 200 0 ## 4 0 0 200 0 ## 4 0 0 200 0 ## 4 0 0 200 0 ## 4 0 0 200 0 ## 4 0 0 200 0 ## 147 222 243 0 ## 201 238 247 0 ## 201 238 247 0 ## 16 230 247 0 ## 9 218 247 0 ## 9 218 247 0 ## 10 0 187 00 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 225 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 348 248 248 0 ## 149 348 248 248 248 248 248 248 248 248 248 2	##	77	225	230	0
## 3 22 234 0 ## 0 181 177 0 ## 0 198 234 0 ## 0 0 200 0 ## 0 200 0 ## 40 35 210 0 ## 147 222 243 0 ## 201 238 247 0 ## 16 230 247 0 ## 9 218 247 0 ## 9 218 247 0 ## 10 0 229 0 ## 10 0 228 0 ## 10 0 228 0 ## 0 0 256 0 ## 10 0 225 0 ## 149 238 248 0 ## 10 0 214 236 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 150 0 193 0 ##	##	67	135	236	0
## 0 181 177 0 ## 0 198 234 0 ## 0 0 200 0 ## 0 0 216 0 ## 40 35 210 0 ## 147 222 243 0 ## 201 238 247 0 ## 201 238 247 0 ## 9 218 247 0 ## 9 218 247 0 ## 9 218 247 0 ## 10 0 29 0 ## 49 221 247 0 ## 10 0 229 0 ## 49 221 247 0 ## 0 0 186 0 ## 0 0 214 229 0 ## 10 0 205 0 ## 0 0 186 0 ## 0 0 186 0 ## 0 0 214 236 0 ## 149 238 248 0 ## 10 0 225 0 ## 149 238 248 0	##	25	222	245	0
## 0 198 234 0 ## 0 0 200 0 ## 0 0 216 0 ## 40 35 210 0 ## 0 0 209 0 ## 147 222 243 0 ## 201 238 247 0 ## 201 238 247 0 ## 9 218 247 0 ## 9 218 247 0 ## 10 0 87 228 0 ## 10 0 229 0 ## 10 0 250 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 225 0 ## 10 0 24 229 0 ## 10 0 25 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 149 338 248 0 ## 30 30 328 0	##	3	22	234	0
## 0 0 0 200 0 ## 40 35 210 0 ## 40 35 210 0 ## 147 222 243 0 ## 201 238 247 0 ## 16 230 247 0 ## 9 218 247 0 ## 9 218 247 0 ## 10 0 0 187 0 ## 10 0 229 0 ## 10 0 187 0 ## 10 0 187 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 225 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 348 248 248 0 ## 149 348 248 248 0 ## 149 348 248 248 248 0 ## 149 348 248 248 248 248 248 248 248 248 248 2	##	0	181	177	0
## 40 0 216 0 ## 40 35 210 0 ## 0 0 209 0 ## 147 222 243 0 ## 201 238 247 0 ## 16 230 247 0 ## 9 218 247 0 ## 0 0 187 0 ## 0 0 187 0 ## 0 0 229 0 ## 10 0 209 0  ## 201 238 247 0 ## 0 0 0 187 0 ## 0 0 0 187 0 ## 0 0 0 187 0 ## 0 0 0 187 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 229 0 ## 10 0 0 186 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 338 248 0 ## 149 0 0 193 0 ## 149 0 0 193 0 ## 157 35 237 0 ## 157 35 237 0 ## 157 35 237 0 ## 157 0 213 0 ## 157 0 1213 0 ## 157 0 1213 0 ## 157 0 1213 0	##	0	198	234	0
##       40       35       210       0         ##       147       222       243       0         ##       0       0       214       0         ##       201       238       247       0         ##       16       230       247       0         ##       9       218       247       0         ##       9       218       247       0         ##       10       0       229       0         ##       49       221       247       0         ##       0       0       205       0         ##       0       0       205       0         ##       0       0       186       0         ##       0       214       236       0         ##       149       238       248       0         ##       0       0       193       0         ##       0       0       193       0         ##       0       0       193       0         ##       0       0       225       0         ##       0       0       237	##	0	0	200	0
## 147 222 243 0 ## 100 0 214 0 ## 201 238 247 0 ## 16 230 247 0 ## 9 218 247 0 ## 9 218 247 0 ## 10 0 87 228 0 ## 10 0 229 0 ## 49 221 247 0 ## 0 0 229 0 ## 49 221 247 0 ## 0 0 205 0 ## 0 0 186 0 ## 0 0 186 0 ## 0 0 186 0 ## 149 238 248 0 ## 10 0 0 125 0 ## 0 0 186 0 ## 0 0 193 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 149 238 248 0 ## 0 0 0 193 0 ## 157 35 237 0 ## 157 35 237 0 ## 157 35 237 0 ## 157 35 237 0 ## 157 35 237 0	##	0	0	216	0
##       147       222       243       0         ##       0       0       214       0         ##       16       238       247       0         ##       0       0       187       0         ##       9       218       247       0         ##       0       87       228       0         ##       10       0       229       0         ##       49       221       247       0         ##       0       0       205       0         ##       0       0       224       229       0         ##       0       0       186       0         ##       0       0       186       0         ##       0       0       214       236       0         ##       0       0       225       0         ##       0       0       193       0         ##       0       0       193       0         ##       137       35       237       0         ##       0       0       213       0         ##       0 <td< th=""><th>##</th><th>40</th><th>35</th><th>210</th><th>0</th></td<>	##	40	35	210	0
##       0       0       214       0         ##       201       238       247       0         ##       16       230       247       0         ##       0       0       187       20         ##       0       87       228       0         ##       10       0       229       0         ##       0       0       221       247       0         ##       0       0       205       0         ##       0       224       229       0         ##       0       214       236       0         ##       0       214       236       0         ##       0       214       236       0         ##       0       225       0         ##       0       0       193       0         ##       0       0       193       0         ##       137       35       237       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213	##	0	0	209	0
##       201       238       247       0         ##       16       230       247       0         ##       0       0       187       0         ##       9       218       247       0         ##       0       87       228       0         ##       49       221       247       0         ##       0       0       205       0         ##       0       224       229       0         ##       0       0       186       0         ##       0       214       236       0         ##       0       214       236       0         ##       0       0       225       0         ##       0       0       193       0         ##       95       226       237       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213	##	147	222	243	0
##       16       230       247       0         ##       0       0       187       0         ##       9       218       247       0         ##       0       87       228       0         ##       10       0       229       0         ##       0       0       205       0         ##       0       0       205       0         ##       0       224       229       0         ##       0       214       236       0         ##       0       214       236       0         ##       0       214       236       0         ##       0       238       248       0         ##       0       0       193       0         ##       95       226       237       0         ##       137       35       237       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213	##	0	0	214	0
##       0       0       187       0         ##       0       87       228       0         ##       10       0       229       0         ##       49       221       247       0         ##       0       0       205       0         ##       0       224       229       0         ##       0       214       236       0         ##       0       214       236       0         ##       0       0       225       0         ##       0       0       193       0         ##       95       226       237       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213       0	##	201	238	247	0
##       9       218       247       0         ##       0       87       228       0         ##       10       0       229       0         ##       49       221       247       0         ##       0       0       205       0         ##       0       224       229       0         ##       0       0       186       0         ##       0       214       236       0         ##       0       0       225       0         ##       0       0       193       0         ##       95       226       237       0         ##       137       35       237       0         ##       0       0       213       0         ##       0       0       213       0	##	16	230	247	0
##     0     87     228     0       ##     10     0     229     0       ##     49     221     247     0       ##     0     0     205     0       ##     0     224     229     0       ##     0     0     186     0       ##     0     214     236     0       ##     149     238     248     0       ##     0     0     225     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     0     213     0	##	0	0	187	0
##       10       0       229       0         ##       49       221       247       0         ##       0       0       205       0         ##       0       224       229       0         ##       0       0       186       0         ##       0       214       236       0         ##       0       225       0         ##       0       0       193       0         ##       95       226       237       0         ##       0       0       213       0         ##       0       0       213       0         ##       0       0       213       0	##	9	218	247	0
##     49     221     247     0       ##     0     0     205     0       ##     0     224     229     0       ##     0     0     186     0       ##     0     214     236     0       ##     149     238     248     0       ##     0     0     225     0       ##     0     0     193     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0	##	0	87	228	0
##     0     0     205     0       ##     0     224     229     0       ##     0     0     186     0       ##     0     214     236     0       ##     149     238     248     0       ##     0     0     225     0       ##     0     0     193     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0					
##     0     224     229     0       ##     0     0     186     0       ##     0     214     236     0       ##     149     238     248     0       ##     0     0     225     0       ##     0     0     193     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0	##				
##     0     0     186     0       ##     0     214     236     0       ##     149     238     248     0       ##     0     0     225     0       ##     0     0     193     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0	##		0		
##     0     214     236     0       ##     149     238     248     0       ##     0     0     225     0       ##     0     0     193     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0	##				
##     149     238     248     0       ##     0     0     225     0       ##     0     0     193     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0	##		0		0
##     0     0     225     0       ##     0     0     193     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0					
##     0     0     193     0       ##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0					
##     95     226     237     0       ##     137     35     237     0       ##     0     0     213     0       ##     0     90     232     0					
## 137 35 237 0 ## 0 0 213 0 ## 0 90 232 0					
## 0 0 213 0 ## 0 90 232 0					
<b>##</b> 0 90 232 0					
## 0 0 177 0					
	##	0	0	177	0

#create data validation rules
rules <- validator(state != "",</pre>

```
year >= 2000,
  year <= 2018,
  race != "",
  age_grp != "",
  count_100k >= 0)
# verify data using rules
confront(bcdata, rules)
## Object of class 'validation'
## Call:
##
      confront(dat = bcdata, x = rules)
##
## Rules confronted: 6
##
     With fails
##
     With missings: 3
##
     Threw warning: 0
##
     Threw error : 0
# The above data checking shows that:
# Arkansas is missing data for year 2000
# Mississippi is missing data for year 2000-2002
# Nevada is missing data for year 2018
# South Dakota is missing data for year 2000
# age_group 20-24 is missing data for almost all (48) states
# Race - American Indian or Alaska Native is missing data for most states (42), as expected
# For an unbiased analysis -
# Remove data for all states for years 2000-2002, 2018
# Remove data for age_group 20-24
bcdata <- bcdata %>%
 filter(year %in% c(2003:2017),
        age_grp != "20-24")
# Verify that no more errors
confront(bcdata, rules)
## Object of class 'validation'
## Call:
##
      confront(dat = bcdata, x = rules)
##
## Rules confronted: 6
## With fails : 0
##
     With missings: 0
##
     Threw warning: 0
##
     Threw error : 0
write_csv(bcdata, here("data", "bcdata.csv"))
```

Save the cleaned data set

### Data Analysis

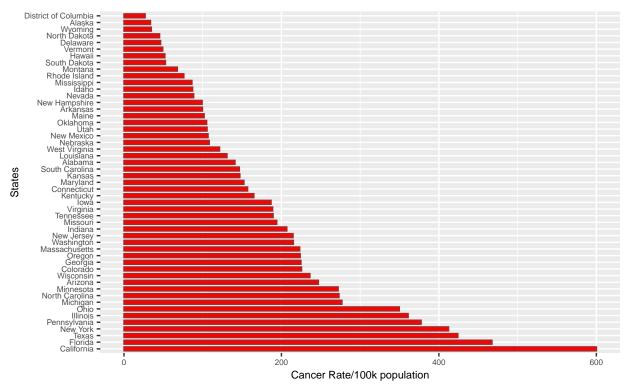
#### Cancer distribution by State

```
# find the mean cancer rate per state
bcdata_state_mean <-
    bcdata %>%
    group_by(state) %>%
    summarise(state_mean = mean(count_100k))

# plot a column graph
bcdata_state_mean %>%
    ggplot(aes(x = state_mean, y = reorder(state, -state_mean))) +
    geom_col(color = "brown", fill="red", width = 0.6) +
    theme(text = element_text(size = 8)) +
    xlab("Cancer Rate/100k population") +
    ylab("States") +
    labs(title = "Breast Cancer Rate by State", subtitle = "Years 2003 - 2017\n")
```

### Breast Cancer Rate by State

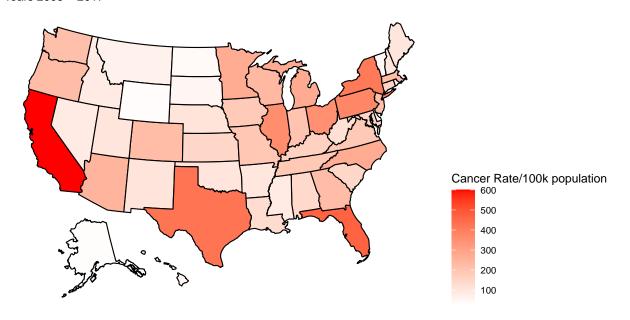
Years 2003 - 2017



```
# plot a map
plot_usmap(data = bcdata_state_mean, regions = "states", values = "state_mean") +
    scale_fill_continuous(name = "Cancer Rate/100k population", low = "white", high = "red") +
    theme(legend.position = "right") +
    labs(title = "Breast Cancer Rate by State", subtitle = "Years 2003 - 2017") +
    theme(plot.title = element_text(face="bold"))
```

### **Breast Cancer Rate by State**

Years 2003 - 2017

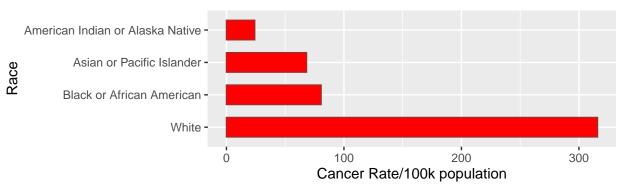


#### Cancer distribution by Race

```
# plot of cancer rate by race
bcdata %>%
  group_by(race) %>%
  summarise(race_rate = mean(count_100k)) %>%
  ggplot(aes(x = race_rate, y = reorder(race, -race_rate))) +
  geom_col(color = "brown", fill="red", width = 0.6) +
  theme(aspect.ratio = 1/3) +
  xlab("Cancer Rate/100k population") +
  ylab("Race") +
  labs(title = "Breast Cancer Rate by Race", subtitle = "Years 2003 - 2017\n") +
  theme(plot.title = element_text(face="bold"))
```

# **Breast Cancer Rate by Race**

Years 2003 - 2017



```
# find the mean cancer rate by Race
bcdata_race <-
bcdata %>%
```

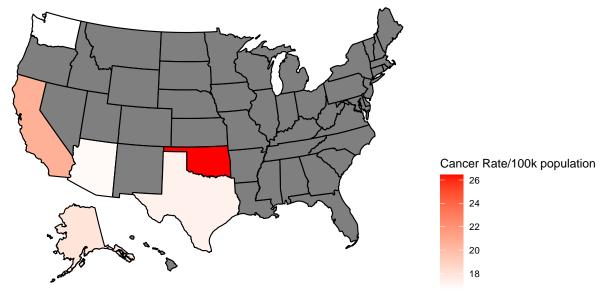
```
group_by(race, state) %>%
summarise(race_mean = mean(count_100k))

# plot race = American Indian
bcdata_race_type <- bcdata_race %>%
    filter(race == "American Indian or Alaska Native")

# plot a map
plot_usmap(data = bcdata_race_type, regions = "states", values = "race_mean") +
    scale_fill_continuous(name = "Cancer Rate/100k population", low = "white", high = "red") +
    theme(legend.position = "right") +
    labs(title = "Cancer Rate by State and Race", subtitle = "Race - American Indian or Alaska Native") +
    theme(plot.title = element_text(face="bold"))
```

### **Cancer Rate by State and Race**

Race - American Indian or Alaska Native

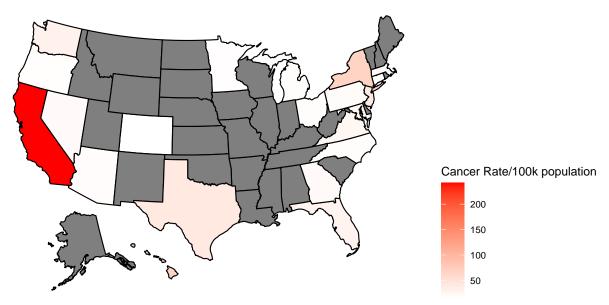


```
# plot race = Asian or Pacific Islander
bcdata_race_type <- bcdata_race %>%
    filter(race == "Asian or Pacific Islander")

# plot a map
plot_usmap(data = bcdata_race_type, regions = "states", values = "race_mean") +
    scale_fill_continuous(name = "Cancer Rate/100k population", low = "white", high = "red") +
    theme(legend.position = "right") +
    labs(title = "Cancer Rate by State and Race", subtitle = "Race - Asian or Pacific Islander") +
    theme(plot.title = element_text(face="bold"))
```

### **Cancer Rate by State and Race**

Race - Asian or Pacific Islander

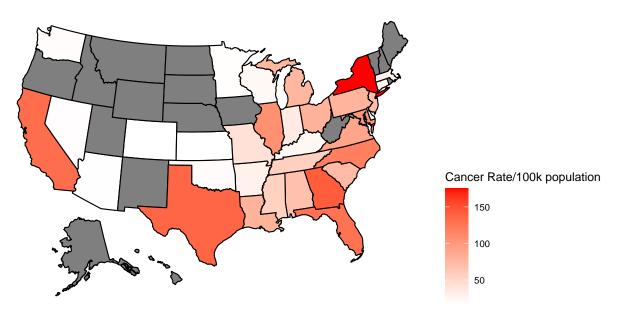


```
# plot race = Black or African American
bcdata_race_type <- bcdata_race %>%
    filter(race == "Black or African American")

# plot a map
plot_usmap(data = bcdata_race_type, regions = "states", values = "race_mean") +
    scale_fill_continuous(name = "Cancer Rate/100k population", low = "white", high = "red") +
    theme(legend.position = "right") +
    labs(title = "Cancer Rate by State and Race", subtitle = "Race - Black or African American") +
    theme(plot.title = element_text(face="bold"))
```

### **Cancer Rate by State and Race**

Race - Black or African American

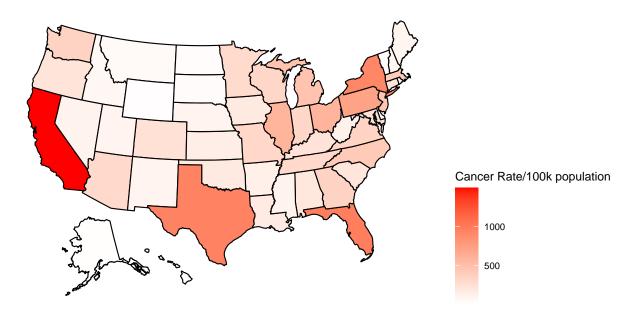


```
# plot race = White
bcdata_race_type <- bcdata_race %>%
    filter(race == "White")

# plot a map
plot_usmap(data = bcdata_race_type, regions = "states", values = "race_mean") +
    scale_fill_continuous(name = "Cancer Rate/100k population", low = "white", high = "red") +
    theme(legend.position = "right") +
    labs(title = "Cancer Rate by State and Race", subtitle = "Race - White") +
    theme(plot.title = element_text(face="bold"))
```

### **Cancer Rate by State and Race**

Race - White



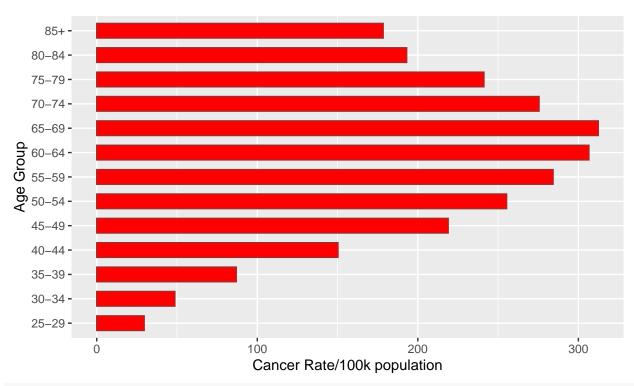
#### Cancer Distribution by Age Group

```
bcdata_age_grp_mean <-
bcdata %>%
  group_by(age_grp) %>%
  summarise(age_grp_rate = mean(count_100k))

# plot the graph
bcdata_age_grp_mean %>%
  ggplot(aes(x = age_grp_rate, y = age_grp)) +
  geom_col(color = "brown", fill="red", width = 0.6) +
  xlab("Cancer Rate/100k population") +
  ylab("Age Group") +
  labs(title = "Breast Cancer Rate by Age Group", subtitle = "Years 2003 - 2017\n") +
  theme(plot.title = element_text(face="bold"))
```

# **Breast Cancer Rate by Age Group**

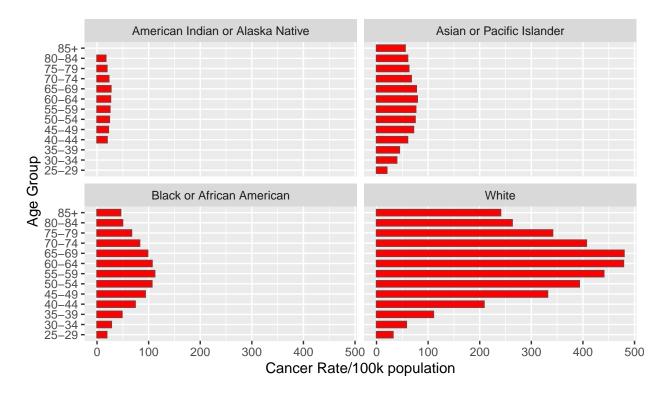
Years 2003 - 2017



```
bcdata %>%
  group_by(age_grp, race) %>%
  summarise(age_grp_rate = mean(count_100k)) %>%
  ggplot(aes(x = age_grp_rate, y = age_grp)) +
  geom_col(color = "brown", fill="red", width = 0.6) +
  xlab("Cancer Rate/100k population") +
  ylab("Age Group") +
  labs(title = "Breast Cancer Rate by Age Group and Race", subtitle = "Years 2003 - 2017\n") +
  theme(plot.title = element_text(face="bold")) +
  facet_wrap(~race)
```

## **Breast Cancer Rate by Age Group and Race**

Years 2003 - 2017



#### Conclusions

The following inferences are derived from the analysis:

- 1. Cancer incidence rate varies by geographical location (State). Since individual states are comprised of populations of different races and ages, it is the composite of these variables that determines the cancer rate of a state. For instance, California and Florida have the highest incidence of cancer rates. Analysis shows us that white women have the highest rate, along with higher rates in late to middle age. Combining these two insights with the tendency of California and Florida to be retirement states is the likely cause that these states have high cancer rates.
- 2. Race has an impact on the cancer rate with White being the highest. This may be due to factors such as lifestyle and genetics, and it is possible for results to be influenced by additional factors listed below.
- 3. Increasing age leads to a higher risk, with a peak at 65-69 years followed by decreasing risk. This is observed across all races, however the overall cancer rate varies by race, with White being the highest.
- 4. There is a relationship between race and age related cancer risk. The pattern of increasing cancer rate as age increases upto 65 years followed by a decline is consistent across all races. However the overall cancer rate varies by race.

Cancer incidence rate variations are also likely due to certain factors not addressed by this analysis.

- $1. \ \, \text{Better access to medical care (Doctor/Hospital to population ratio) that leads to a higher detection/incidence rate}$
- 2. Dietary choices
- 3. Income levels that afford access to medical care or restrict it

4. Awareness and motivation for regular breast cancer screening

To summarise, there are numerous factors, many of which are outside the scope of this analysis that play a part in predicting a breast cancer probability. The variables used in this analysis are historical statistics that only serve as trend indicators and merit deeper scientific scrutiny with relevent datasets.