

# Final Project: Cancer Incidence Rate

*Tzu-Chun Hsieh*

## Summary

The purpose of this analysis is to identify whether the geographical factors would affect the probability of people contracting cancer. The conclusion shows that the differences in cancer incidence rates among states are statistically significant, controlling for other demographic factors. However, the analysis only offers an overview and fails to reveal what might be the characteristic of the states that cause the variation. Further studies including other factors would be able to examine the exact reason why some states have higher cancer incidence rates.

## Introduction

Cancer has become one of the most common diseases that modern people would contract during their lifetime. In the United States, cancer is ranked second among the leading causes of death. Though some bad habits such as smoking are known as the causes of cancer, in many cases, no clear reason is responsible for the disease. For example, people who never smoke might get lung cancer as well. This analysis would attempt to identify the geographical factors that may affect the probability of a person contracting cancer. Specifically, the study aims to investigate the following questions:

- Does living in different states affect the possibility of developing cancer?
- Are the states with relatively high cancer incidence rates located in specific areas?

## Data

Two data sources are used to obtain sufficient information for this analysis. First, the population data from NHGIS. The population data on the website is obtained directly from the U.S. Census, which is conducted by the United States Census Bureau. The cancer incidence numbers are downloaded from the CDC WONDER. The data is originally provided by the United States Cancer Statistics that obtains the data from cancer registries. The population data set will be combined with the cancer data set on the state, year, age, race, and sex. Moreover, a new column- "Cancer incidence rate" would be added to the data set by calculating the ratio of the incidence number and the population. The final dataset used in the analysis includes 42893 observations. The response variable for the analysis is the cancer incidence rate.

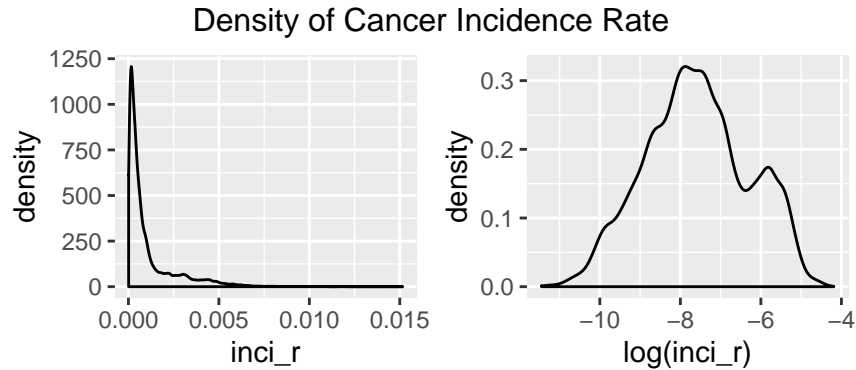
## Code book:

The codebook for the data set used in this analysis is as follow:

	Description
inci	The number of cancer incidence
inci_r	Cancer incidence rate
c_site	Leading Cancer site
pop	Population for the demographic group
state	States of United States (except Alaska)
year	From 2012 to 2016
age	All age
race	White, Black or African American, Asian or Pacific Islander
gender	1 = female, 0 = male

### Data processing:

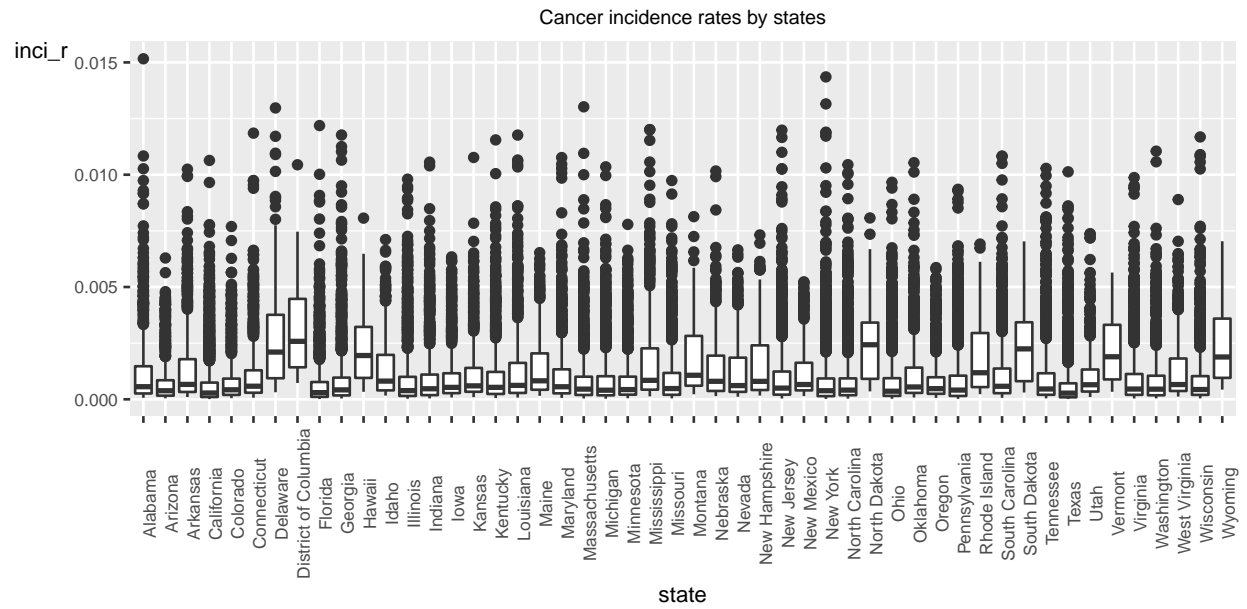
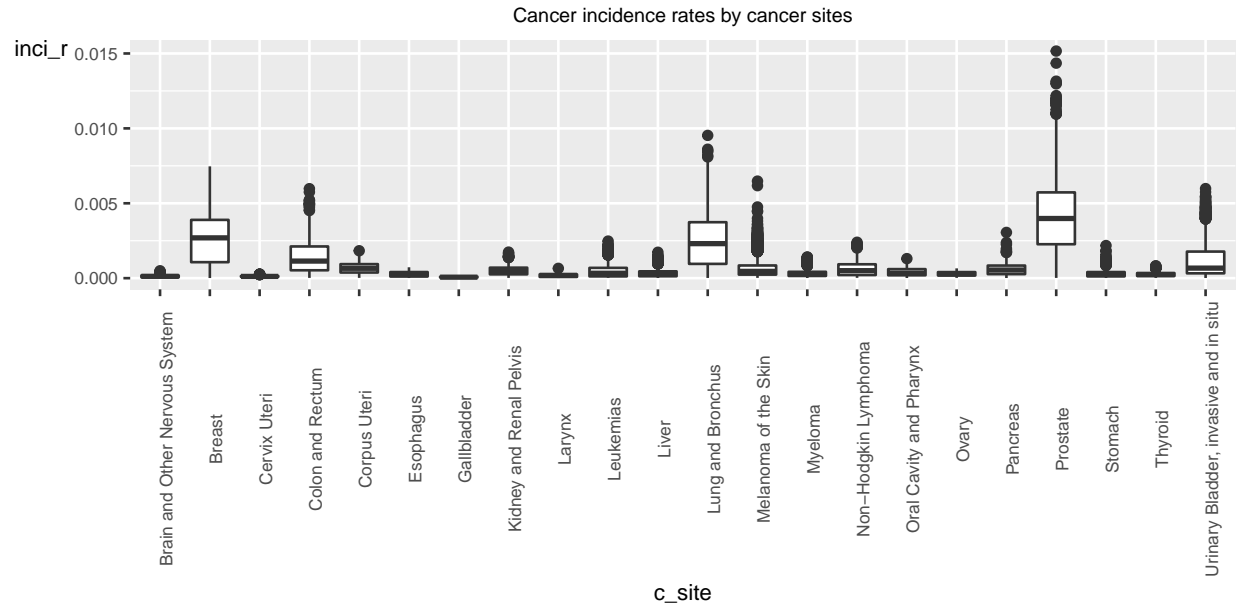
The value of cancer incidence rates is small and the distribution is skewed. Therefore, I tried square root, cube root, and log transformation to improve the distribution towards being a normal distribution. It turns out that log transformation best improved the distribution but there is still a sub-distribution.

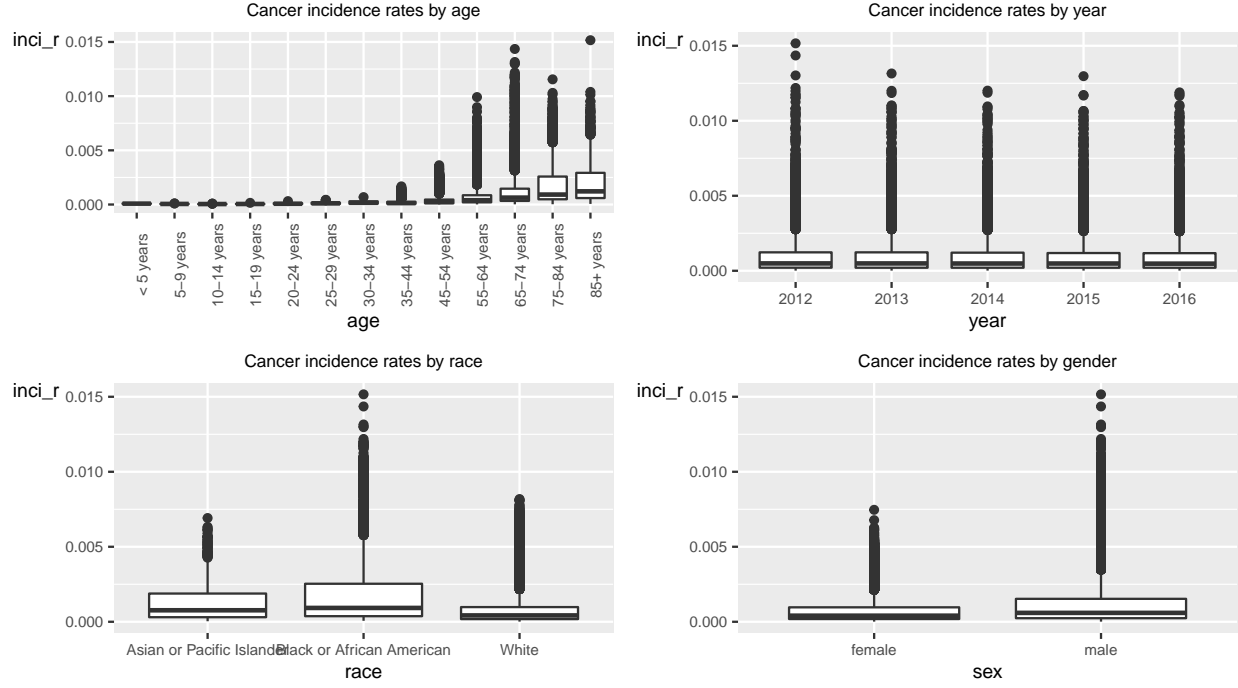


### Exploratory data analysis:

Based on the initial data analysis, the following is concluded:

- The cancer incidence rate of different cancer sites varies tremendously. Among all types of cancer, breast cancer, lung and bronchus cancer, and prostate cancer are typical cancer types in the United States.
- The cancer incidence rates differ among states. For example, Washington, D.C., has three times of cancer incidence rate compared to other states such as Arizona and Arkansas.
- Cancer is more prevalent in the elderly. The cancer incidence rate approximately doubles between the age group of “45-54 years” old and “55-64 years” old and doubles repeatedly between the age group of “55-64 years” and “65-74 years”.
- The cancer incidence rates seem to have decreased during the 5-year-period. However, the difference in the cancer incidence rates between 2012 and 2016 is only 0.007%.
- Black people are more likely to develop cancer comparing to Asian people and white people.
- Women are approximately 30% less possible to contract cancer than men.





## Model

### Final model:

The final model for this analysis is as follow:

$$\log(pop_i inci\_r_i) = \hat{\beta}_0 + \hat{\beta}_1 \mathbf{x}_{state\ i} + \hat{\beta}_2 \mathbf{x}_{c\_site\ i} + \hat{\beta}_3 \mathbf{x}_{year\ i} + \hat{\beta}_4 \mathbf{x}_{age\ i} + \hat{\beta}_5 \mathbf{x}_{race\ i} + \hat{\beta}_6 \mathbf{x}_{sex\ i} + \hat{\beta}_7 \mathbf{x}_{c\_site*sex*age\ i} + \log(pop_i)$$

When answering the questions I interested in, I set population as 1 to get the formula for log cancer incidence rates, which is as follow:

$$\log(inci\_r_i) = \hat{\beta}_0 + \hat{\beta}_1 \mathbf{x}_{state\ i} + \hat{\beta}_2 \mathbf{x}_{c\_site\ i} + \hat{\beta}_3 \mathbf{x}_{year\ i} + \hat{\beta}_4 \mathbf{x}_{age\ i} + \hat{\beta}_5 \mathbf{x}_{race\ i} + \hat{\beta}_6 \mathbf{x}_{sex\ i} + \hat{\beta}_7 \mathbf{x}_{c\_site*sex*age\ i}$$

\*Please refer to the appendix for the full result of the model.

### Model selection:

First, I tried to fit the linear model. I used stepwise with the full model with all predictor variables to fit the model. It turns out that all the predictor variables are included in the model. However, there is a cluster in residual plot. Therefore, I tried the possible interaction term and find the interaction term: cancer sites:sex:age would solve the problem. All the predictor variables in the model with interaction term are all significant. However, the residuals are not randomly scattered. Moreover, the assumption of normality is not followed according to the QQ plot.

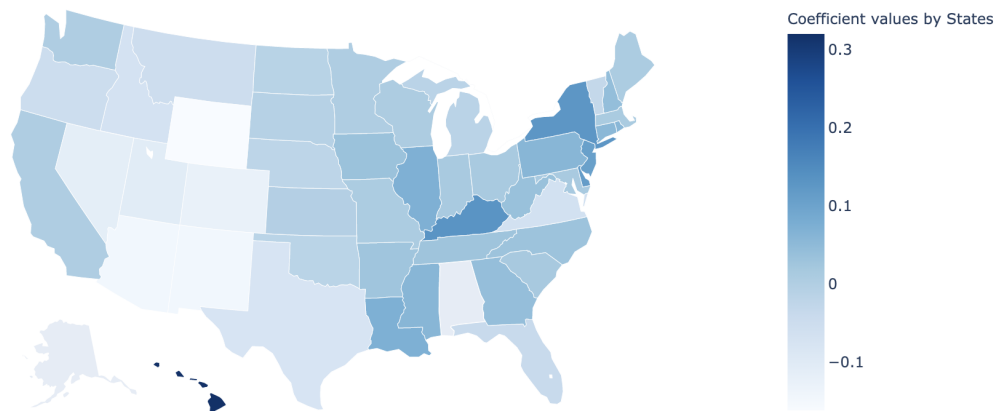
Therefore, I try a hierarchical linear model, which level is state, to fix the problem. However, it turns out that the residual plot and qqplot do not change.

Finally, I use the Poisson model to solve the normality problem which is caused by the fact that the distribution of log cancer incidence rate is not normally distributed. To fit the Poisson model, I use cancer incidence number as response variables instead. However, by setting the population value as 1, I can get the model use cancer incidence rate as the response variable to answer the questions of this analysis.

## Results:

According to the final model, approximately all the predictor variables are statistically significant. People live in different states would have different cancer incidence rates when other factors are controlled. The largest difference is between Hawaii and Wyoming. People live in Hawaii have a 53% greater possibility to develop cancer than people live in Wyoming. Moreover, according to the heat map of the coefficient of all states, generally, people living in states on the east coast are more probably to develop cancer.

Coefficient values by States



In addition to states, other factors show the same direction of impacts that previously observed in EDA. Male is 30% more possible to develop cancer than women. Moreover, White Americans are 45% more possible to develop cancer while Black Americans are 64% more possible to develop cancer compared to Asian Americans. Furthermore, the coefficients of the interaction term capture the fact that some cancer are more common in specific gender and age.

## Conclusion

According to the model, living in different states affects the probability of contracting cancer. The differences are statistically significant. However, some of the cancer incidence numbers were discarded when pulling out data from the website because the number is too small for that category, which people might be identified by the data. To protect privacy, these cancer incidence numbers are not available from the data source. In future research, other factors related to the characteristic of the states should be included to explore deep insights on this topic.

## Appendix

The final poisson model:

term	estimate	std.error	statistic	p.value
(Intercept)	-1.013700e+01	1.600000e-02	-622.686	0.000
stateArizona	-1.440000e-01	4.000000e-03	-33.434	0.000
stateArkansas	3.000000e-02	5.000000e-03	5.744	0.000
stateCalifornia	7.000000e-03	3.000000e-03	2.071	0.038
stateColorado	-1.210000e-01	5.000000e-03	-25.962	0.000
stateConnecticut	5.800000e-02	5.000000e-03	12.119	0.000
stateDelaware	1.170000e-01	9.000000e-03	13.252	0.000
stateDistrict of Columbia	-4.700000e-02	1.600000e-02	-2.823	0.005
stateFlorida	-3.600000e-02	3.000000e-03	-10.524	0.000
stateGeorgia	4.400000e-02	4.000000e-03	11.391	0.000
stateHawaii	3.210000e-01	8.000000e-03	37.883	0.000
stateIdaho	-6.700000e-02	7.000000e-03	-9.582	0.000
stateIllinois	7.400000e-02	4.000000e-03	20.021	0.000
stateIndiana	1.500000e-02	4.000000e-03	3.710	0.000
stateIowa	3.600000e-02	5.000000e-03	7.293	0.000
stateKansas	-2.000000e-03	5.000000e-03	-0.280	0.780
stateKentucky	1.340000e-01	4.000000e-03	30.399	0.000
stateLouisiana	7.500000e-02	5.000000e-03	16.467	0.000
stateMaine	1.100000e-02	7.000000e-03	1.653	0.098
stateMaryland	1.700000e-02	4.000000e-03	4.019	0.000
stateMassachusetts	1.500000e-02	4.000000e-03	3.638	0.000
stateMichigan	-1.300000e-02	4.000000e-03	-3.429	0.001
stateMinnesota	6.000000e-03	4.000000e-03	1.298	0.194
stateMississippi	6.200000e-02	5.000000e-03	11.725	0.000
stateMissouri	1.100000e-02	4.000000e-03	2.684	0.007
stateMontana	-4.600000e-02	8.000000e-03	-5.490	0.000
stateNebraska	-1.700000e-02	6.000000e-03	-2.703	0.007
stateNevada	-1.090000e-01	6.000000e-03	-18.249	0.000
stateNew Hampshire	4.500000e-02	7.000000e-03	6.563	0.000
stateNew Jersey	1.090000e-01	4.000000e-03	28.136	0.000
stateNew Mexico	-1.440000e-01	7.000000e-03	-21.235	0.000
stateNew York	1.290000e-01	3.000000e-03	37.080	0.000
stateNorth Carolina	3.400000e-02	4.000000e-03	8.864	0.000
stateNorth Dakota	-1.000000e-02	1.100000e-02	-0.913	0.361
stateOhio	1.600000e-02	4.000000e-03	4.451	0.000
stateOklahoma	-1.300000e-02	5.000000e-03	-2.666	0.008
stateOregon	-4.500000e-02	5.000000e-03	-9.594	0.000
statePennsylvania	6.200000e-02	4.000000e-03	17.188	0.000
stateRhode Island	5.800000e-02	8.000000e-03	7.019	0.000
stateSouth Carolina	1.900000e-02	4.000000e-03	4.378	0.000
stateSouth Dakota	-6.000000e-03	1.000000e-02	-0.571	0.568
stateTennessee	3.100000e-02	4.000000e-03	7.625	0.000
stateTexas	-7.400000e-02	3.000000e-03	-21.012	0.000
stateUtah	-1.020000e-01	6.000000e-03	-16.263	0.000
stateVermont	-2.900000e-02	1.100000e-02	-2.633	0.008
stateVirginia	-6.200000e-02	4.000000e-03	-15.270	0.000
stateWashington	6.000000e-03	4.000000e-03	1.537	0.124
stateWest Virginia	3.800000e-02	6.000000e-03	6.477	0.000
stateWisconsin	1.000000e-02	4.000000e-03	2.376	0.017

term	estimate	std.error	statistic	p.value
stateWyoming	-1.600000e-01	1.400000e-02	-11.140	0.000
c_siteBreast	-1.054314e+11	4.318254e+10	-2.442	0.015
c_siteCervix Uteri	-1.666605e+12	5.307170e+11	-3.140	0.002
c_siteColon and Rectum	7.472157e+08	7.005638e+10	0.011	0.991
c_siteCorpus Uteri	-1.482546e+11	1.218364e+11	-1.217	0.224
c_siteEsophagus	5.605955e+11	2.570181e+11	2.181	0.029
c_siteGallbladder	2.406445e+10	4.796744e+11	0.050	0.960
c_siteKidney and Renal Pelvis	2.978000e+00	6.772000e+00	0.440	0.660
c_siteLarynx	5.504400e+01	3.390700e+01	1.623	0.105
c_siteLeukemias	5.070000e-01	1.900000e-02	26.696	0.000
c_siteLiver	8.882779e+11	3.665988e+11	2.423	0.015
c_siteLung and Bronchus	1.085962e+11	1.907753e+11	0.569	0.569
c_siteMelanoma of the Skin	-3.523145e+10	6.216414e+10	-0.567	0.571
c_siteMyeloma	3.702974e+11	1.388773e+12	0.267	0.790
c_siteNon-Hodgkin Lymphoma	2.113685e+10	1.298324e+11	0.163	0.871
c_siteOral Cavity and Pharynx	1.423928e+11	2.417419e+11	0.589	0.556
c_siteOvary	9.603472e+11	2.566340e+11	3.742	0.000
c_sitePancreas	-4.892082e+11	3.717527e+11	-1.316	0.188
c_siteProstate	-1.946999e+11	2.874970e+11	-0.677	0.498
c_siteStomach	-5.236672e+11	6.275336e+11	-0.834	0.404
c_siteThyroid	2.514193e+11	1.647896e+11	1.526	0.127
c_siteUrinary Bladder, invasive and in situ	-4.981854e+11	2.907424e+11	-1.713	0.087
year.L	-3.200000e-02	1.000000e-03	-35.930	0.000
year.Q	-1.000000e-02	1.000000e-03	-10.971	0.000
year.C	-8.000000e-03	1.000000e-03	-9.506	0.000
year^4	-6.000000e-03	1.000000e-03	-7.106	0.000
age.L	1.884000e+00	4.700000e-02	39.738	0.000
age.Q	1.329000e+00	4.800000e-02	27.567	0.000
age.C	-4.060000e-01	5.400000e-02	-7.471	0.000
age^4	-4.370000e-01	4.800000e-02	-9.153	0.000
age^5	-7.800000e-02	4.900000e-02	-1.579	0.114
age^6	-1.370000e-01	5.300000e-02	-2.590	0.010
age^7	1.890000e-01	5.100000e-02	3.734	0.000
age^8	1.790000e-01	5.100000e-02	3.479	0.001
age^9	-1.610000e-01	5.600000e-02	-2.860	0.004
age^10	-7.800000e-02	6.200000e-02	-1.264	0.206
age^11	-3.000000e-02	6.000000e-02	-0.490	0.624
age^12	1.280000e-01	5.400000e-02	2.369	0.018
raceBlack or African American	4.960000e-01	3.000000e-03	149.688	0.000
raceWhite	3.690000e-01	3.000000e-03	120.768	0.000
sexmale	2.650000e-01	1.900000e-02	14.007	0.000
c_siteBreast:sexmale	-2.113900e+01	1.028400e+01	-2.056	0.040
c_siteColon and Rectum:sexmale	-1.426976e+11	1.215335e+11	-1.174	0.240
c_siteEsophagus:sexmale	-8.065800e+01	2.833000e+01	-2.847	0.004
c_siteGallbladder:sexmale	-1.048800e+01	5.026000e+00	-2.087	0.037
c_siteKidney and Renal Pelvis:sexmale	-1.068100e+01	8.308000e+00	-1.286	0.199
c_siteLarynx:sexmale	-7.911000e+01	3.532100e+01	-2.240	0.025
c_siteLeukemias:sexmale	1.050000e-01	2.300000e-02	4.534	0.000
c_siteLiver:sexmale	-4.589860e+09	6.558792e+11	-0.007	0.994
c_siteLung and Bronchus:sexmale	-1.549263e+11	1.189738e+11	-1.302	0.193
c_siteMelanoma of the Skin:sexmale	-2.376592e+11	1.484967e+11	-1.600	0.110
c_siteMyeloma:sexmale	-8.366000e+00	1.405700e+01	-0.595	0.552

term	estimate	std.error	statistic	p.value
c_siteNon-Hodgkin Lymphoma:sexmale	8.132931e+10	1.457473e+11	0.558	0.577
c_siteOral Cavity and Pharynx:sexmale	9.198329e+11	3.789870e+11	2.427	0.015
c_sitePancreas:sexmale	1.266027e+11	5.052409e+11	0.251	0.802
c_siteStomach:sexmale	7.662951e+11	7.376824e+11	1.039	0.299
c_siteThyroid:sexmale	-1.829205e+11	5.889166e+11	-0.311	0.756
c_siteUrinary Bladder, invasive and in situ:sexmale	-5.339000e+00	1.248700e+01	-0.428	0.669
c_siteBreast:age.L	5.818691e+11	2.383127e+11	2.442	0.015
c_siteCervix Uteri:age.L	9.160038e+12	2.916946e+12	3.140	0.002
c_siteColon and Rectum:age.L	-4.200205e+09	3.938027e+11	-0.011	0.991
c_siteCorpus Uteri:age.L	7.954798e+11	6.537562e+11	1.217	0.224
c_siteEsophagus:age.L	-2.778189e+12	1.273739e+12	-2.181	0.029
c_siteGallbladder:age.L	-1.122237e+11	2.236990e+12	-0.050	0.960
c_siteKidney and Renal Pelvis:age.L	-8.469000e+00	2.812200e+01	-0.301	0.763
c_siteLarynx:age.L	-2.607280e+02	1.566700e+02	-1.664	0.096
c_siteLeukemias:age.L	9.670000e-01	5.700000e-02	16.912	0.000
c_siteLiver:age.L	-4.402111e+12	1.816764e+12	-2.423	0.015
c_siteLung and Bronchus:age.L	-5.351210e+11	9.400553e+11	-0.569	0.569
c_siteMelanoma of the Skin:age.L	1.944402e+11	3.430947e+11	0.567	0.571
c_siteMyeloma:age.L	-1.807308e+12	6.778225e+12	-0.267	0.790
c_siteNon-Hodgkin Lymphoma:age.L	-1.454289e+11	7.397376e+11	-0.197	0.844
c_siteOral Cavity and Pharynx:age.L	-7.409508e+11	1.257885e+12	-0.589	0.556
c_siteOvary:age.L	-5.381637e+12	1.438146e+12	-3.742	0.000
c_sitePancreas:age.L	2.424409e+12	1.842361e+12	1.316	0.188
c_siteProstate:age.L	9.594078e+11	1.416664e+12	0.677	0.498
c_siteStomach:age.L	2.709456e+12	3.245803e+12	0.835	0.404
c_siteThyroid:age.L	-1.431617e+12	9.383204e+11	-1.526	0.127
c_siteUrinary Bladder, invasive and in situ:age.L	2.454870e+12	1.432721e+12	1.713	0.087
c_siteBreast:age.Q	-5.848005e+11	2.395117e+11	-2.442	0.015
c_siteCervix Uteri:age.Q	-9.125711e+12	2.906006e+12	-3.140	0.002
c_siteColon and Rectum:age.Q	4.383725e+09	4.110094e+11	0.011	0.991
c_siteCorpus Uteri:age.Q	-7.538023e+11	6.194738e+11	-1.217	0.224
c_siteEsophagus:age.Q	2.221056e+12	1.018292e+12	2.181	0.029
c_siteGallbladder:age.Q	7.830786e+10	1.560919e+12	0.050	0.960
c_siteKidney and Renal Pelvis:age.Q	2.325000e+00	1.031700e+01	0.225	0.822
c_siteLarynx:age.Q	1.803010e+02	1.073930e+02	1.679	0.093
c_siteLeukemias:age.Q	9.860000e-01	5.700000e-02	17.190	0.000
c_siteLiver:age.Q	3.519320e+12	1.452419e+12	2.423	0.015
c_siteLung and Bronchus:age.Q	4.225704e+11	7.423350e+11	0.569	0.569
c_siteMelanoma of the Skin:age.Q	-1.954197e+11	3.448102e+11	-0.567	0.571
c_siteMyeloma:age.Q	1.398638e+12	5.245416e+12	0.267	0.790
c_siteNon-Hodgkin Lymphoma:age.Q	2.096303e+11	8.016761e+11	0.261	0.794
c_siteOral Cavity and Pharynx:age.Q	6.581799e+11	1.117358e+12	0.589	0.556
c_siteOvary:age.Q	5.580455e+12	1.491321e+12	3.742	0.000
c_sitePancreas:age.Q	-1.938223e+12	1.473042e+12	-1.316	0.188
c_siteProstate:age.Q	-7.576180e+11	1.118760e+12	-0.677	0.498
c_siteStomach:age.Q	-2.377315e+12	2.848649e+12	-0.835	0.404
c_siteThyroid:age.Q	1.534014e+12	1.005448e+12	1.526	0.127
c_siteUrinary Bladder, invasive and in situ:age.Q	-1.938544e+12	1.131290e+12	-1.714	0.087
c_siteBreast:age.C	4.712880e+11	1.930323e+11	2.441	0.015
c_siteCervix Uteri:age.C	7.247162e+12	2.307871e+12	3.140	0.002
c_siteColon and Rectum:age.C	-3.749119e+09	3.515085e+11	-0.011	0.991
c_siteCorpus Uteri:age.C	5.522598e+11	4.538458e+11	1.217	0.224



term	estimate	std.error	statistic	p.value
c_siteEsophagus:age.C	-1.218863e+12	5.588150e+11	-2.181	0.029
c_siteGallbladder:age.C	-3.329559e+10	6.636896e+11	-0.050	0.960
c_siteKidney and Renal Pelvis:age.C	5.875000e+00	1.209000e+01	0.486	0.627
c_siteLarynx:age.C	-7.650000e+01	4.429400e+01	-1.727	0.084
c_siteLeukemias:age.C	-9.000000e-03	6.500000e-02	-0.138	0.890
c_siteLiver:age.C	-1.931320e+12	7.970874e+11	-2.423	0.015
c_siteLung and Bronchus:age.C	-2.270317e+11	3.988104e+11	-0.569	0.569
c_siteMelanoma of the Skin:age.C	1.574879e+11	2.778733e+11	0.567	0.571
c_siteMyeloma:age.C	-7.268366e+11	2.725890e+12	-0.267	0.790
c_siteNon-Hodgkin Lymphoma:age.C	-2.590014e+11	7.435139e+11	-0.348	0.728
c_siteOral Cavity and Pharynx:age.C	-4.334323e+11	7.358372e+11	-0.589	0.556
c_siteOvary:age.C	-4.722126e+12	1.261907e+12	-3.742	0.000
c_sitePancreas:age.C	1.063651e+12	8.083403e+11	1.316	0.188
c_siteProstate:age.C	4.070406e+11	6.010510e+11	0.677	0.498
c_siteStomach:age.C	1.532694e+12	1.836406e+12	0.835	0.404
c_siteThyroid:age.C	-1.366608e+12	8.957233e+11	-1.526	0.127
c_siteUrinary Bladder, invasive and in situ:age.C	1.041509e+12	6.078199e+11	1.714	0.087
c_siteBreast:age <sup>4</sup>	-3.147640e+11	1.289117e+11	-2.442	0.015
c_siteCervix Uteri:age <sup>4</sup>	-4.729918e+12	1.506213e+12	-3.140	0.002
c_siteColon and Rectum:age <sup>4</sup>	2.726537e+09	2.556502e+11	0.011	0.991
c_siteCorpus Uteri:age <sup>4</sup>	-3.196643e+11	2.626986e+11	-1.217	0.224
c_siteEsophagus:age <sup>4</sup>	4.383372e+11	2.009669e+11	2.181	0.029
c_siteGallbladder:age <sup>4</sup>	7.046441e+09	1.404573e+11	0.050	0.960
c_siteKidney and Renal Pelvis:age <sup>4</sup>	-9.952000e+00	2.434400e+01	-0.409	0.683
c_siteLarynx:age <sup>4</sup>	1.680900e+01	9.122000e+00	1.843	0.065
c_siteLeukemias:age <sup>4</sup>	3.100000e-02	5.900000e-02	0.521	0.602
c_siteLiver:age <sup>4</sup>	6.945564e+11	2.866488e+11	2.423	0.015
c_siteLung and Bronchus:age <sup>4</sup>	7.884761e+10	1.385093e+11	0.569	0.569
c_siteMelanoma of the Skin:age <sup>4</sup>	-1.051831e+11	1.856017e+11	-0.567	0.571
c_siteMyeloma:age <sup>4</sup>	2.398644e+11	8.996031e+11	0.267	0.790
c_siteNon-Hodgkin Lymphoma:age <sup>4</sup>	2.746437e+11	6.251257e+11	0.439	0.660
c_siteOral Cavity and Pharynx:age <sup>4</sup>	2.125559e+11	3.608740e+11	0.589	0.556
c_siteOvary:age <sup>4</sup>	3.379088e+12	9.030062e+11	3.742	0.000
c_sitePancreas:age <sup>4</sup>	-3.825185e+11	2.907009e+11	-1.316	0.188
c_siteProstate:age <sup>4</sup>	-1.413643e+11	2.087523e+11	-0.677	0.498
c_siteStomach:age <sup>4</sup>	-7.258652e+11	8.696841e+11	-0.835	0.404
c_siteThyroid:age <sup>4</sup>	1.052325e+12	6.897250e+11	1.526	0.127
c_siteUrinary Bladder, invasive and in situ:age <sup>4</sup>	-3.617137e+11	2.110820e+11	-1.714	0.087
c_siteBreast:age <sup>5</sup>	1.739924e+11	7.126065e+10	2.442	0.015
c_siteCervix Uteri:age <sup>5</sup>	2.521184e+12	8.028575e+11	3.140	0.002
c_siteColon and Rectum:age <sup>5</sup>	-1.695544e+09	1.589681e+11	-0.011	0.991
c_siteCorpus Uteri:age <sup>5</sup>	1.427201e+11	1.172931e+11	1.217	0.224
c_siteEsophagus:age <sup>5</sup>	-8.181558e+10	3.751056e+10	-2.181	0.029
c_siteKidney and Renal Pelvis:age <sup>5</sup>	6.873000e+00	2.283700e+01	0.301	0.763
c_siteLeukemias:age <sup>5</sup>	-1.640000e-01	6.100000e-02	-2.688	0.007
c_siteLiver:age <sup>5</sup>	-1.296389e+11	5.350171e+10	-2.423	0.015
c_siteLung and Bronchus:age <sup>5</sup>	-1.386784e+10	2.436097e+10	-0.569	0.569
c_siteMelanoma of the Skin:age <sup>5</sup>	5.814212e+10	1.025930e+11	0.567	0.571
c_siteMyeloma:age <sup>5</sup>	-3.903083e+10	1.463844e+11	-0.267	0.790
c_siteNon-Hodgkin Lymphoma:age <sup>5</sup>	-2.495064e+11	4.841913e+11	-0.515	0.606
c_siteOral Cavity and Pharynx:age <sup>5</sup>	-7.273482e+10	1.234816e+11	-0.589	0.556
c_siteOvary:age <sup>5</sup>	-2.050985e+12	5.480853e+11	-3.742	0.000

term	estimate	std.error	statistic	p.value
c_sitePancreas:age <sup>5</sup>	7.139703e+10	5.425505e+10	1.316	0.188
c_siteProstate:age <sup>5</sup>	2.486338e+10	3.671481e+10	0.677	0.498
c_siteStomach:age <sup>5</sup>	2.340550e+11	2.804844e+11	0.834	0.404
c_siteThyroid:age <sup>5</sup>	-7.063431e+11	4.629578e+11	-1.526	0.127
c_siteUrinary Bladder, invasive and in situ:age <sup>5</sup>	6.361880e+10	3.713094e+10	1.713	0.087
c_siteBreast:age <sup>6</sup>	-7.790643e+10	3.190944e+10	-2.441	0.015
c_siteCervix Uteri:age <sup>6</sup>	-1.062475e+12	3.383392e+11	-3.140	0.002
c_siteColon and Rectum:age <sup>6</sup>	8.931683e+08	8.374066e+10	0.011	0.991
c_siteCorpus Uteri:age <sup>6</sup>	-4.564575e+10	3.751297e+10	-1.217	0.224
c_siteKidney and Renal Pelvis:age <sup>6</sup>	-1.709000e+00	1.380600e+01	-0.124	0.901
c_siteLeukemias:age <sup>6</sup>	1.790000e-01	6.500000e-02	2.763	0.006
c_siteMelanoma of the Skin:age <sup>6</sup>	-2.603359e+10	4.593584e+10	-0.567	0.571
c_siteNon-Hodgkin Lymphoma:age <sup>6</sup>	1.939728e+11	3.418594e+11	0.567	0.570
c_siteOral Cavity and Pharynx:age <sup>6</sup>	1.402911e+10	2.381662e+10	0.589	0.556
c_siteOvary:age <sup>6</sup>	1.040790e+12	2.781363e+11	3.742	0.000
c_siteStomach:age <sup>6</sup>	-4.030766e+10	4.829351e+10	-0.835	0.404
c_siteThyroid:age <sup>6</sup>	4.112497e+11	2.695521e+11	1.526	0.127
c_siteBreast:age <sup>7</sup>	2.696243e+10	1.104255e+10	2.442	0.015
c_siteCervix Uteri:age <sup>7</sup>	3.279874e+11	1.044473e+11	3.140	0.002
c_siteColon and Rectum:age <sup>7</sup>	-3.892549e+08	3.649527e+10	-0.011	0.991
c_siteCorpus Uteri:age <sup>7</sup>	8.425287e+09	6.923973e+09	1.217	0.224
c_siteGallbladder:age <sup>7</sup>	-1.492519e+08	2.975079e+09	-0.050	0.960
c_siteKidney and Renal Pelvis:age <sup>7</sup>	-9.360000e-01	5.340000e+00	-0.175	0.861
c_siteLeukemias:age <sup>7</sup>	-1.410000e-01	6.300000e-02	-2.229	0.026
c_siteMelanoma of the Skin:age <sup>7</sup>	9.009894e+09	1.589788e+10	0.567	0.571
c_siteNon-Hodgkin Lymphoma:age <sup>7</sup>	-1.286228e+11	2.150360e+11	-0.598	0.550
c_siteOvary:age <sup>7</sup>	-4.265577e+11	1.139892e+11	-3.742	0.000
c_siteThyroid:age <sup>7</sup>	-2.043202e+11	1.339167e+11	-1.526	0.127
c_siteBreast:age <sup>8</sup>	-6.536119e+09	2.677002e+09	-2.442	0.015
c_siteCervix Uteri:age <sup>8</sup>	-5.981662e+10	1.904805e+10	-3.140	0.002
c_siteColon and Rectum:age <sup>8</sup>	1.340927e+08	1.257246e+10	0.011	0.991
c_siteEsophagus:age <sup>8</sup>	1.418514e+09	6.503534e+08	2.181	0.029
c_siteKidney and Renal Pelvis:age <sup>8</sup>	6.950000e-01	1.060000e+00	0.655	0.512
c_siteLeukemias:age <sup>8</sup>	-1.210000e-01	6.500000e-02	-1.852	0.064
c_siteLiver:age <sup>8</sup>	2.247672e+09	9.276099e+08	2.423	0.015
c_siteMelanoma of the Skin:age <sup>8</sup>	-2.184141e+09	3.853969e+09	-0.567	0.571
c_siteNon-Hodgkin Lymphoma:age <sup>8</sup>	7.220999e+10	1.175538e+11	0.614	0.539
c_siteOral Cavity and Pharynx:age <sup>8</sup>	-5.044290e+08	8.563853e+08	-0.589	0.556
c_siteOvary:age <sup>8</sup>	1.309788e+11	3.500191e+10	3.742	0.000
c_sitePancreas:age <sup>8</sup>	-1.237878e+09	9.407553e+08	-1.316	0.188
c_siteThyroid:age <sup>8</sup>	8.379211e+10	5.492015e+10	1.526	0.127
c_siteBreast:age <sup>9</sup>	8.529037e+08	3.493263e+08	2.442	0.015
c_siteColon and Rectum:age <sup>9</sup>	-3.324596e+07	3.117410e+09	-0.011	0.991
c_siteCorpus Uteri:age <sup>9</sup>	-2.998322e+08	2.464070e+08	-1.217	0.224
c_siteLeukemias:age <sup>9</sup>	1.090000e-01	7.000000e-02	1.567	0.117
c_siteLung and Bronchus:age <sup>9</sup>	1.523939e+08	2.677164e+08	0.569	0.569
c_siteMelanoma of the Skin:age <sup>9</sup>	2.850104e+08	5.029165e+08	0.567	0.571
c_siteNon-Hodgkin Lymphoma:age <sup>9</sup>	-3.386715e+10	5.450838e+10	-0.621	0.534
c_siteOvary:age <sup>9</sup>	-2.441648e+10	6.524842e+09	-3.742	0.000
c_siteProstate:age <sup>9</sup>	-2.732240e+08	4.034293e+08	-0.677	0.498
c_siteStomach:age <sup>9</sup>	6.430081e+08	7.705717e+08	0.834	0.404
c_siteThyroid:age <sup>9</sup>	-2.644065e+10	1.732999e+10	-1.526	0.127

term	estimate	std.error	statistic	p.value
c_siteUrinary Bladder, invasive and in situ:age <sup>9</sup>	-6.991076e+08	4.080119e+08	-1.713	0.087
c_siteCervix Uteri:age <sup>10</sup>	2.284178e+09	7.273854e+08	3.140	0.002
c_siteColon and Rectum:age <sup>10</sup>	4.608460e+06	4.320982e+08	0.011	0.991
c_siteLeukemias:age <sup>10</sup>	2.100000e-02	7.500000e-02	0.280	0.779
c_siteNon-Hodgkin Lymphoma:age <sup>10</sup>	1.297050e+10	2.082936e+10	0.623	0.533
c_siteThyroid:age <sup>10</sup>	5.258660e+09	3.446792e+09	1.526	0.127
c_siteLeukemias:age <sup>11</sup>	7.300000e-02	7.500000e-02	0.977	0.328
c_siteNon-Hodgkin Lymphoma:age <sup>11</sup>	-3.884829e+09	6.252819e+09	-0.621	0.534
c_siteOvary:age <sup>11</sup>	1.120305e+09	2.993830e+08	3.742	0.000
c_siteLeukemias:age <sup>12</sup>	-5.700000e-02	7.000000e-02	-0.811	0.418
c_siteMyeloma:age <sup>12</sup>	9.229885e+08	3.461466e+09	0.267	0.790
c_siteNon-Hodgkin Lymphoma:age <sup>12</sup>	8.100427e+08	1.303766e+09	0.621	0.534
c_siteThyroid:age <sup>12</sup>	-3.613794e+08	2.368624e+08	-1.526	0.127
age.L:sexmale	4.600000e-01	6.100000e-02	7.567	0.000
age.Q:sexmale	-2.900000e-02	6.000000e-02	-0.485	0.628
age.C:sexmale	-6.600000e-02	6.600000e-02	-1.001	0.317
age <sup>4</sup> :sexmale	3.100000e-02	6.000000e-02	0.519	0.604
age <sup>5</sup> :sexmale	3.200000e-02	6.100000e-02	0.518	0.605
age <sup>6</sup> :sexmale	3.300000e-02	6.400000e-02	0.520	0.603
age <sup>7</sup> :sexmale	1.000000e-02	6.200000e-02	0.153	0.878
age <sup>8</sup> :sexmale	-4.300000e-02	6.400000e-02	-0.679	0.497
age <sup>9</sup> :sexmale	-1.200000e-02	6.800000e-02	-0.177	0.859
age <sup>10</sup> :sexmale	2.300000e-02	7.400000e-02	0.305	0.761
age <sup>11</sup> :sexmale	9.900000e-02	7.300000e-02	1.365	0.172
age <sup>12</sup> :sexmale	-1.040000e-01	6.600000e-02	-1.580	0.114
c_siteBreast:age.L:sexmale	6.733400e+01	4.303500e+01	1.565	0.118
c_siteColon and Rectum:age.L:sexmale	7.996551e+11	6.810550e+11	1.174	0.240
c_siteEsophagus:age.L:sexmale	3.687960e+02	1.288550e+02	2.862	0.004
c_siteGallbladder:age.L:sexmale	3.289100e+01	1.776900e+01	1.851	0.064
c_siteKidney and Renal Pelvis:age.L:sexmale	4.505700e+01	3.449900e+01	1.306	0.192
c_siteLarynx:age.L:sexmale	3.663450e+02	1.631600e+02	2.245	0.025
c_siteLeukemias:age.L:sexmale	9.400000e-02	7.300000e-02	1.284	0.199
c_siteLiver:age.L:sexmale	2.261710e+10	3.231925e+12	0.007	0.994
c_siteLung and Bronchus:age.L:sexmale	7.677810e+11	5.896079e+11	1.302	0.193
c_siteMelanoma of the Skin:age.L:sexmale	1.306229e+12	8.161717e+11	1.600	0.110
c_siteMyeloma:age.L:sexmale	3.723600e+01	6.463000e+01	0.576	0.565
c_siteNon-Hodgkin Lymphoma:age.L:sexmale	-4.470043e+11	8.010603e+11	-0.558	0.577
c_siteOral Cavity and Pharynx:age.L:sexmale	-4.759219e+12	1.960880e+12	-2.427	0.015
c_sitePancreas:age.L:sexmale	-6.238504e+11	2.489637e+12	-0.251	0.802
c_siteStomach:age.L:sexmale	-3.964814e+12	3.816772e+12	-1.039	0.299
c_siteThyroid:age.L:sexmale	1.005372e+12	3.236819e+12	0.311	0.756
c_siteUrinary Bladder, invasive and in situ:age.L:sexmale	2.877500e+01	5.742200e+01	0.501	0.616
c_siteBreast:age.Q:sexmale	-3.391900e+01	2.320500e+01	-1.462	0.144
c_siteColon and Rectum:age.Q:sexmale	-8.291973e+11	7.062158e+11	-1.174	0.240
c_siteEsophagus:age.Q:sexmale	-2.398810e+02	8.532700e+01	-2.811	0.005
c_siteGallbladder:age.Q:sexmale	-9.794000e+00	6.095000e+00	-1.607	0.108
c_siteKidney and Renal Pelvis:age.Q:sexmale	-1.563100e+01	1.266000e+01	-1.235	0.217
c_siteLarynx:age.Q:sexmale	-2.446400e+02	1.117680e+02	-2.189	0.029
c_siteLeukemias:age.Q:sexmale	1.560000e-01	7.200000e-02	2.154	0.031
c_siteLiver:age.Q:sexmale	-1.786010e+10	2.552163e+12	-0.007	0.994
c_siteLung and Bronchus:age.Q:sexmale	-6.138117e+11	4.713690e+11	-1.302	0.193
c_siteMelanoma of the Skin:age.Q:sexmale	-1.301333e+12	8.131131e+11	-1.600	0.110

term	estimate	std.error	statistic	p.value
c_siteMyeloma:age.Q:sexmale	-2.289100e+01	4.375300e+01	-0.523	0.601
c_siteNon-Hodgkin Lymphoma:age.Q:sexmale	4.453292e+11	7.980583e+11	0.558	0.577
c_siteOral Cavity and Pharynx:age.Q:sexmale	4.175806e+12	1.720504e+12	2.427	0.015
c_sitePancreas:age.Q:sexmale	4.926376e+11	1.965998e+12	0.251	0.802
c_siteStomach:age.Q:sexmale	3.478783e+12	3.348889e+12	1.039	0.299
c_siteThyroid:age.Q:sexmale	-1.001605e+12	3.224689e+12	-0.311	0.756
c_siteUrinary Bladder, invasive and in situ:age.Q:sexmale	-1.906500e+01	3.888800e+01	-0.490	0.624
c_siteBreast:age.C:sexmale	8.874000e+00	5.685000e+00	1.561	0.119
c_siteColon and Rectum:age.C:sexmale	7.016587e+11	5.975929e+11	1.174	0.240
c_siteEsophagus:age.C:sexmale	8.999600e+01	3.330600e+01	2.702	0.007
c_siteKidney and Renal Pelvis:age.C:sexmale	-1.995100e+01	1.482900e+01	-1.345	0.179
c_siteLarynx:age.C:sexmale	9.763000e+01	4.604900e+01	2.120	0.034
c_siteLeukemias:age.C:sexmale	1.940000e-01	8.000000e-02	2.437	0.015
c_siteLiver:age.C:sexmale	9.595584e+09	1.371184e+12	0.007	0.994
c_siteLung and Bronchus:age.C:sexmale	3.368454e+11	2.586762e+11	1.302	0.193
c_siteMelanoma of the Skin:age.C:sexmale	1.033451e+12	6.457319e+11	1.600	0.110
c_siteMyeloma:age.C:sexmale	8.102000e+00	1.767300e+01	0.458	0.647
c_siteNon-Hodgkin Lymphoma:age.C:sexmale	-3.536571e+11	6.337762e+11	-0.558	0.577
c_siteOral Cavity and Pharynx:age.C:sexmale	-2.692210e+12	1.109237e+12	-2.427	0.015
c_sitePancreas:age.C:sexmale	-2.646762e+11	1.056259e+12	-0.251	0.802
c_siteStomach:age.C:sexmale	-2.242828e+12	2.159084e+12	-1.039	0.299
c_siteThyroid:age.C:sexmale	7.954220e+11	2.560880e+12	0.311	0.756
c_siteUrinary Bladder, invasive and in situ:age.C:sexmale	8.140000e+00	1.571800e+01	0.518	0.605
c_siteColon and Rectum:age^4:sexmale	-5.020972e+11	4.276291e+11	-1.174	0.240
c_siteEsophagus:age^4:sexmale	-1.596500e+01	6.196000e+00	-2.577	0.010
c_siteKidney and Renal Pelvis:age^4:sexmale	3.841500e+01	2.986500e+01	1.286	0.198
c_siteLarynx:age^4:sexmale	-1.961400e+01	9.459000e+00	-2.074	0.038
c_siteLeukemias:age^4:sexmale	-1.910000e-01	7.500000e-02	-2.540	0.011
c_siteLiver:age^4:sexmale	-3.332525e+09	4.762092e+11	-0.007	0.994
c_siteLung and Bronchus:age^4:sexmale	-1.211390e+11	9.302717e+10	-1.302	0.193
c_siteMelanoma of the Skin:age^4:sexmale	-6.744900e+11	4.214421e+11	-1.600	0.110
c_siteMyeloma:age^4:sexmale	-1.161000e+00	3.459000e+00	-0.336	0.737
c_siteNon-Hodgkin Lymphoma:age^4:sexmale	2.308172e+11	4.136391e+11	0.558	0.577
c_siteOral Cavity and Pharynx:age^4:sexmale	1.274998e+12	5.253211e+11	2.427	0.015
c_sitePancreas:age^4:sexmale	9.192147e+10	3.668364e+11	0.251	0.802
c_siteStomach:age^4:sexmale	1.062176e+12	1.022516e+12	1.039	0.299
c_siteThyroid:age^4:sexmale	-5.191385e+11	1.671378e+12	-0.311	0.756
c_siteUrinary Bladder, invasive and in situ:age^4:sexmale	-1.830000e+00	3.079000e+00	-0.594	0.552
c_siteColon and Rectum:age^5:sexmale	3.047549e+11	2.595555e+11	1.174	0.240
c_siteKidney and Renal Pelvis:age^5:sexmale	-3.531000e+01	2.801900e+01	-1.260	0.208
c_siteLeukemias:age^5:sexmale	-1.530000e-01	7.600000e-02	-2.006	0.045
c_siteLiver:age^5:sexmale	5.861299e+08	8.375645e+10	0.007	0.994
c_siteLung and Bronchus:age^5:sexmale	2.261058e+10	1.736351e+10	1.302	0.193
c_siteMelanoma of the Skin:age^5:sexmale	3.595227e+11	2.246408e+11	1.600	0.110
c_siteNon-Hodgkin Lymphoma:age^5:sexmale	-1.230322e+11	2.204816e+11	-0.558	0.577
c_siteOral Cavity and Pharynx:age^5:sexmale	-4.111227e+11	1.693896e+11	-2.427	0.015
c_sitePancreas:age^5:sexmale	-1.616730e+10	6.451979e+10	-0.251	0.802
c_siteStomach:age^5:sexmale	-3.424984e+11	3.297099e+11	-1.039	0.299
c_siteThyroid:age^5:sexmale	2.767159e+11	8.908932e+11	0.311	0.756
c_siteColon and Rectum:age^6:sexmale	-1.546506e+11	1.317137e+11	-1.174	0.240
c_siteKidney and Renal Pelvis:age^6:sexmale	2.095500e+01	1.694000e+01	1.237	0.216
c_siteLeukemias:age^6:sexmale	1.090000e-01	8.000000e-02	1.366	0.172

term	estimate	std.error	statistic	p.value
c_siteMelanoma of the Skin:age <sup>6</sup> :sexmale	-1.515097e+11	9.466794e+10	-1.600	0.110
c_siteNon-Hodgkin Lymphoma:age <sup>6</sup> :sexmale	5.184813e+10	9.291516e+10	0.558	0.577
c_siteOral Cavity and Pharynx:age <sup>6</sup> :sexmale	7.080129e+10	2.917135e+10	2.427	0.015
c_siteStomach:age <sup>6</sup> :sexmale	5.898319e+10	5.678083e+10	1.039	0.299
c_siteThyroid:age <sup>6</sup> :sexmale	-1.166134e+11	3.754394e+11	-0.311	0.756
c_siteColon and Rectum:age <sup>7</sup> :sexmale	6.338202e+10	5.398158e+10	1.174	0.240
c_siteKidney and Renal Pelvis:age <sup>7</sup> :sexmale	-7.808000e+00	6.553000e+00	-1.192	0.233
c_siteLeukemias:age <sup>7</sup> :sexmale	4.100000e-02	7.900000e-02	0.517	0.605
c_siteMelanoma of the Skin:age <sup>7</sup> :sexmale	4.677126e+10	2.922412e+10	1.600	0.110
c_siteNon-Hodgkin Lymphoma:age <sup>7</sup> :sexmale	-1.600559e+10	2.868303e+10	-0.558	0.577
c_siteThyroid:age <sup>7</sup> :sexmale	3.599870e+10	1.158986e+11	0.311	0.756
c_siteColon and Rectum:age <sup>8</sup> :sexmale	-1.946209e+10	1.657559e+10	-1.174	0.240
c_siteKidney and Renal Pelvis:age <sup>8</sup> :sexmale	1.448000e+00	1.302000e+00	1.112	0.266
c_siteLeukemias:age <sup>8</sup> :sexmale	-2.700000e-02	8.200000e-02	-0.327	0.743
c_siteLung and Bronchus:age <sup>8</sup> :sexmale	-3.920210e+08	3.010476e+08	-1.302	0.193
c_siteMelanoma of the Skin:age <sup>8</sup> :sexmale	-8.529896e+09	5.329741e+09	-1.600	0.110
c_siteNon-Hodgkin Lymphoma:age <sup>8</sup> :sexmale	2.919015e+09	5.231061e+09	0.558	0.577
c_siteThyroid:age <sup>8</sup> :sexmale	-6.565253e+09	2.113698e+10	-0.311	0.756
c_siteColon and Rectum:age <sup>9</sup> :sexmale	3.628035e+09	3.089946e+09	1.174	0.240
c_siteLeukemias:age <sup>9</sup> :sexmale	5.200000e-02	8.500000e-02	0.610	0.542
c_siteLiver:age <sup>9</sup> :sexmale	-6.440988e+06	9.204006e+08	-0.007	0.994
c_siteOral Cavity and Pharynx:age <sup>9</sup> :sexmale	-1.129458e+09	4.653560e+08	-2.427	0.015
c_sitePancreas:age <sup>9</sup> :sexmale	1.776626e+08	7.090086e+08	0.251	0.802
c_siteStomach:age <sup>9</sup> :sexmale	-9.409296e+08	9.057963e+08	-1.039	0.299
c_siteLeukemias:age <sup>10</sup> :sexmale	-3.900000e-02	9.200000e-02	-0.420	0.674
c_siteMelanoma of the Skin:age <sup>10</sup> :sexmale	3.257255e+08	2.035233e+08	1.600	0.110
c_siteNon-Hodgkin Lymphoma:age <sup>10</sup> :sexmale	-1.114665e+08	1.997551e+08	-0.558	0.577
c_siteThyroid:age <sup>10</sup> :sexmale	2.507030e+08	8.071440e+08	0.311	0.756
c_siteColon and Rectum:age <sup>11</sup> :sexmale	-1.664656e+08	1.417765e+08	-1.174	0.240
c_siteLeukemias:age <sup>11</sup> :sexmale	-5.200000e-02	9.100000e-02	-0.568	0.570
c_siteLeukemias:age <sup>12</sup> :sexmale	8.100000e-02	8.700000e-02	0.932	0.351