Case Studies in Mortality: Quantifying & interpreting all-cause and cause specific US mortality trend

Handout

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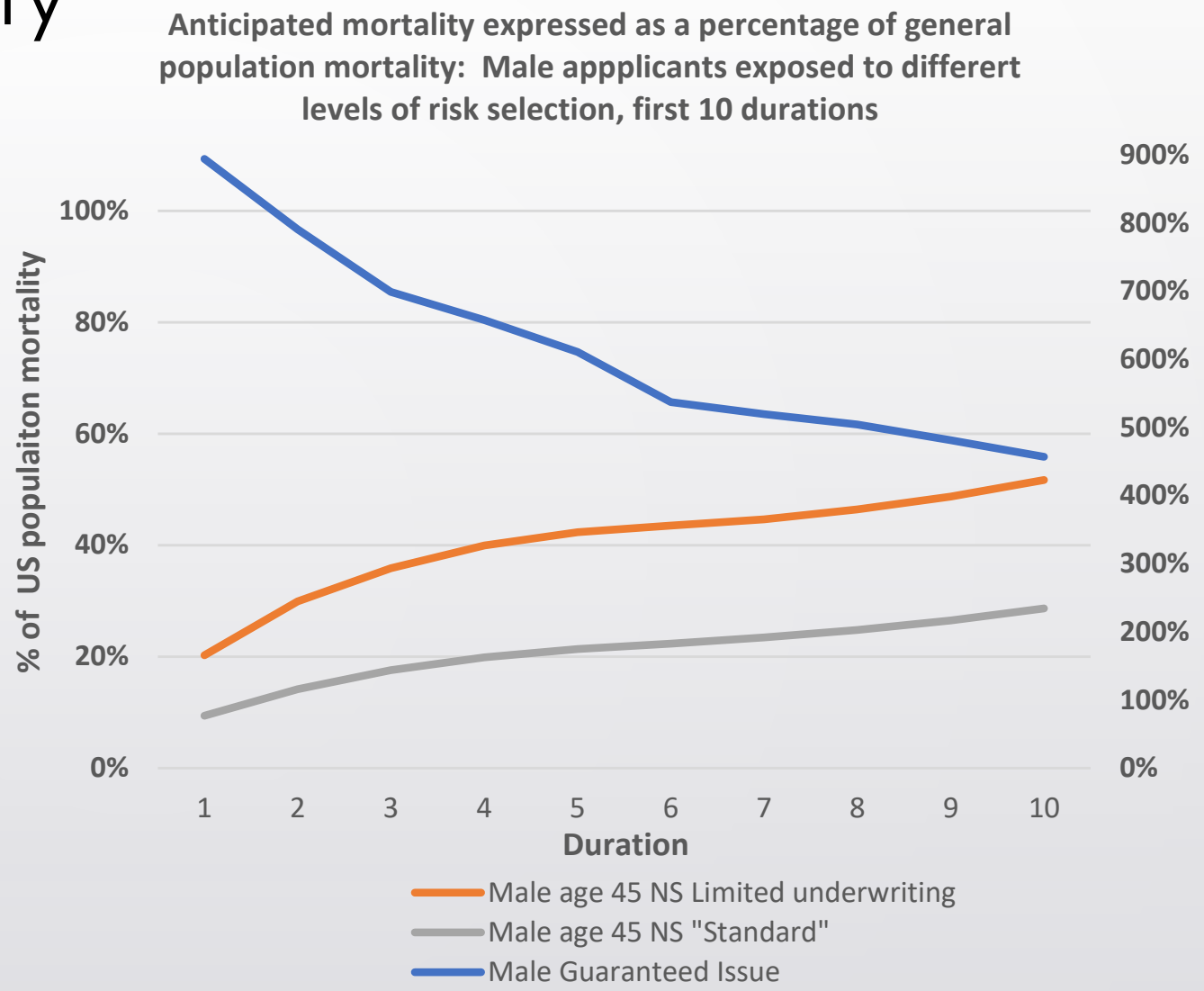
Presenting issues

- How can we better understand emerging all cause and cause specific mortality trends in the general population and pop subsets with characteristics more similar to the applicant pool?
- Are these trends relevant to the underwriting and pricing approach your company should take?

For all of the above: What resources are available to medical directors to help answer these questions?

Applicant pool mortality

Further expansion of sales into the middle market and competitive variability in risk assessment practices has increased the range of expected mortality that may be observed in applicants.



Mortality and Other Rate Tables (soa.org)

U.S. Life Tables for 2008 (cdc.gov)

Quantifying US mortality trend

- With certain insurance products designed to perform over a larger range of population mortality, emerging mortality trends in the general population and subsets of that population may be useful to identify and understand when considering future mortality trends in insurance applicants and policyholders.
- We will work thru examples from an on-line US vital statistics data source that can help quantify recent mortality trend
  - Quantify US mortality trend for males age 45-64 over the past 15 years.
  - Determine whether high per capita income influences the trend you observed above, where a high per capita income group might be more reflective of trend observed in insured groups.

CDC WONDER

WONDER stands for: **Wide-ranging ONline Data for Epidemiologic Research**

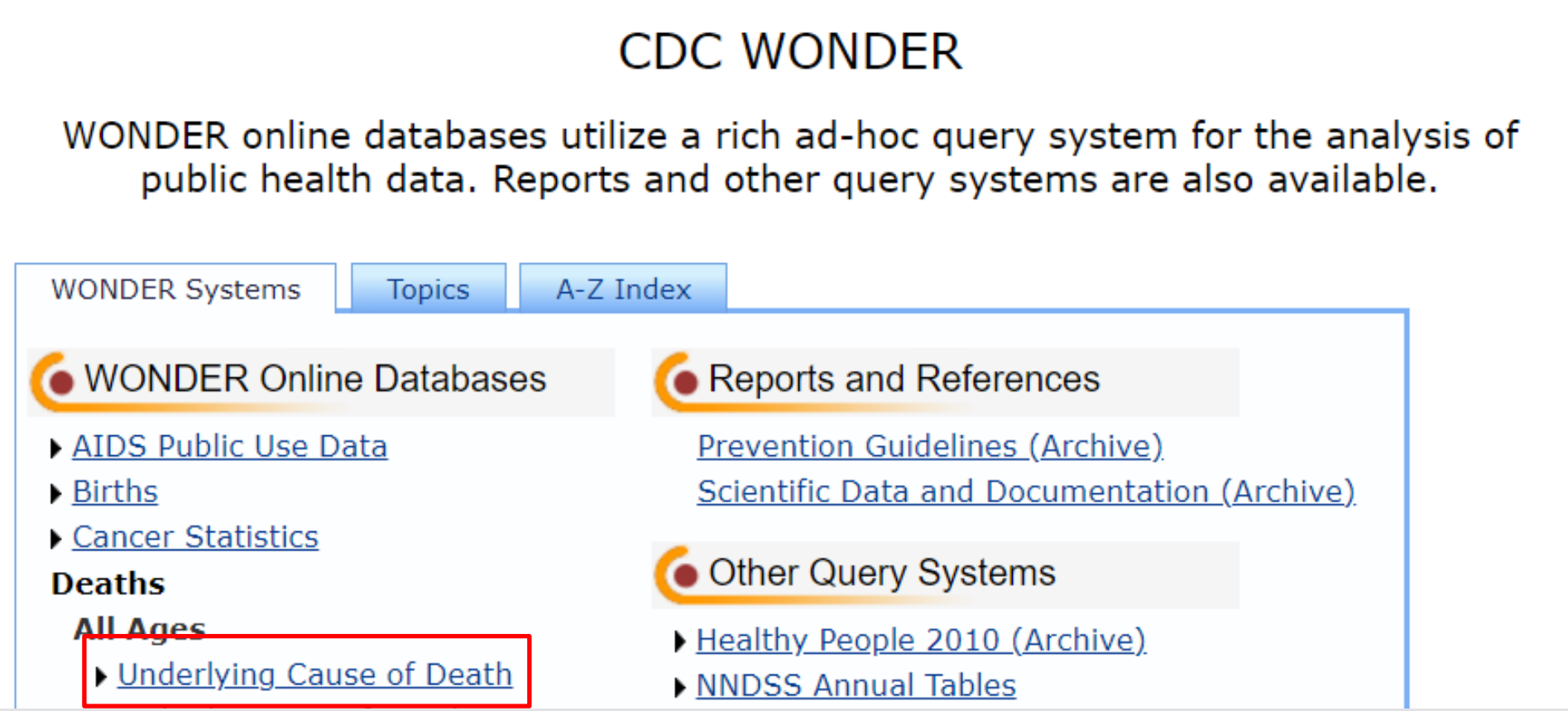
"an easy-to-use, menu-driven system that makes the information resources of the Centers for Disease Control and Prevention (CDC) available to public health professionals and the public at large"

- WONDER provides access to may different public data sources. The one we will focus on is US all cause death rate data, later showing how NVSS rapid release data can highlight even more recent US cause specific death rate trends.

Underlying Cause of Death, 1999-2020 Request (cdc.gov)

Mortality trend in US males age 45-64

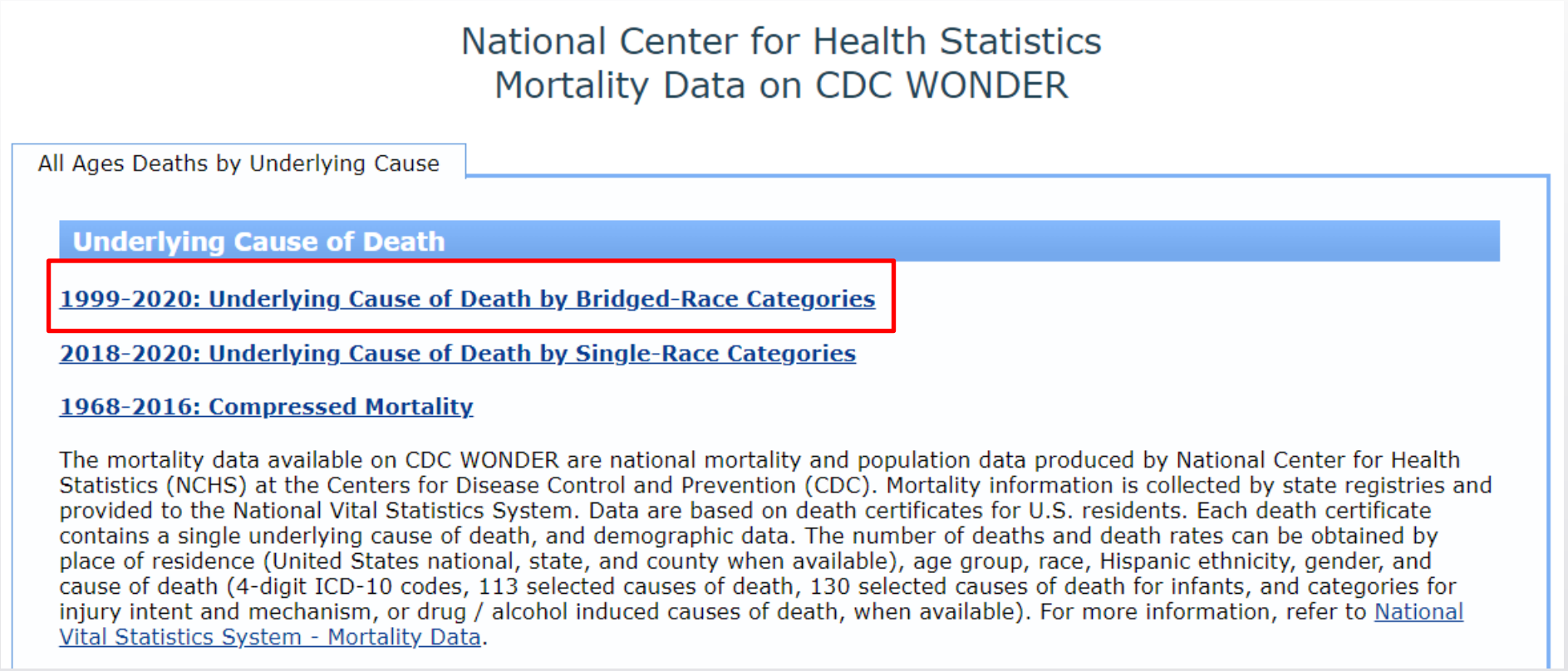
Navigate to CDC WONDER, Deaths-All ages-Underlying cause of death and click on "Underlying Cause of Death"



CDC WONDER

Mortality trend in US males age 45-64

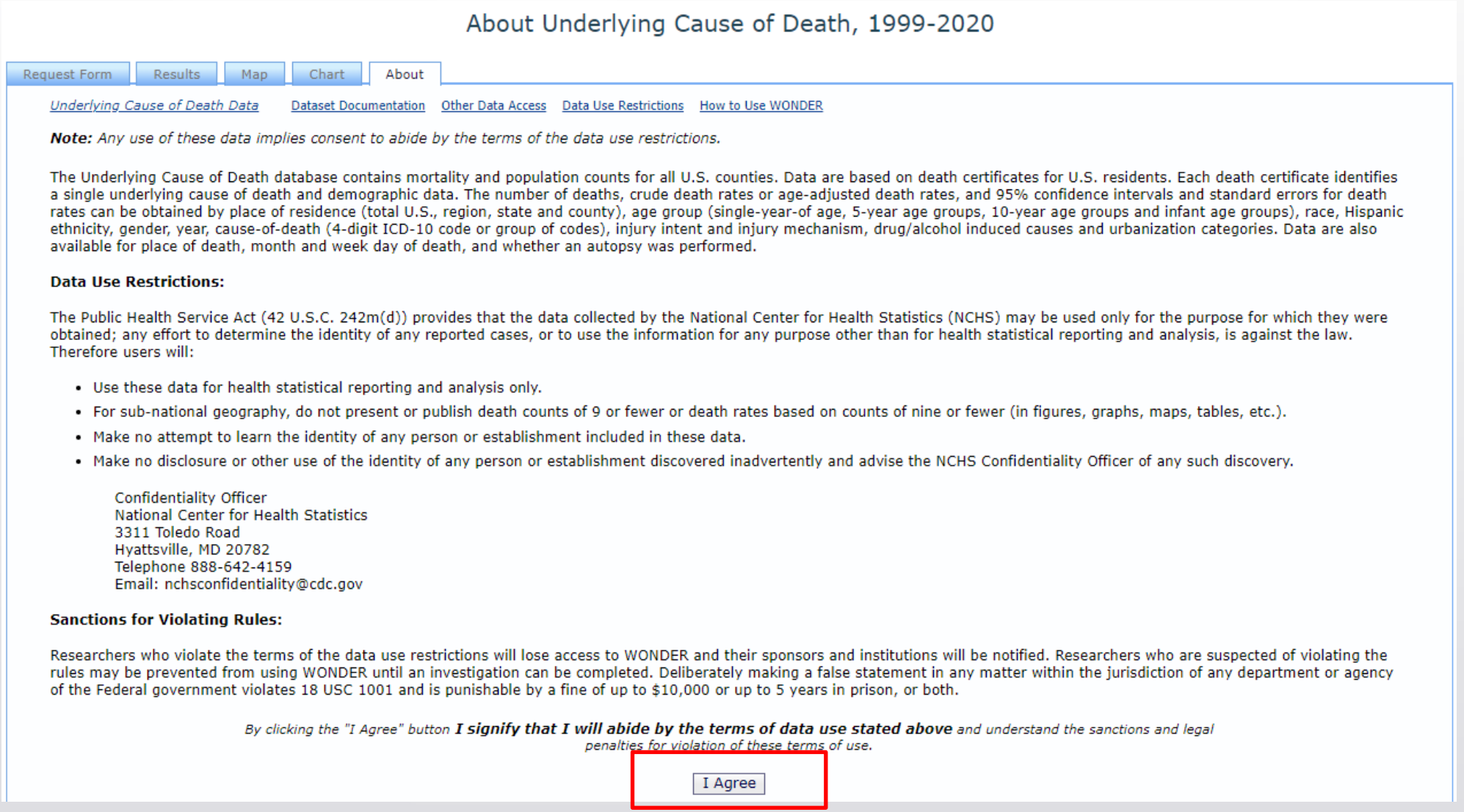
Select 1999-2020: Underlying COD by bridged race categories.



Deaths (cdc.gov)

Mortality trend in US males age 45-64

Agree to the terms of use.



About Underlying Cause of Death, 1999-2020

Request Form | Results | Map | Chart | About

Underlying Cause of Death Data | Dataset Documentation | Other Data Access | Data Use Restrictions | How to Use WONDER

Note: *Any use of these data implies consent to abide by the terms of the data use restrictions.*

The Underlying Cause of Death database contains mortality and population counts for all U.S. counties. Data are based on death certificates for U.S. residents. Each death certificate identifies a single underlying cause of death and demographic data. The number of deaths, crude death rates or age-adjusted death rates, and 95% confidence intervals and standard errors for death rates can be obtained by place of residence (total U.S., region, state and county), age group (single-year-of age, 5-year age groups, 10-year age groups and infant age groups), race, Hispanic ethnicity, gender, year, cause-of-death (4-digit ICD-10 code or group of codes), injury intent and injury mechanism, drug/alcohol induced causes and urbanization categories. Data are also available for place of death, month and week day of death, and whether an autopsy was performed.

Data Use Restrictions:

The Public Health Service Act (42 U.S.C. 242m(d)) provides that the data collected by the National Center for Health Statistics (NCHS) may be used only for the purpose for which they were obtained; any effort to determine the identity of any reported cases, or to use the information for any purpose other than for health statistical reporting and analysis, is against the law. Therefore users will:

- Use these data for health statistical reporting and analysis only.
- For sub-national geography, do not present or publish death counts of 9 or fewer or death rates based on counts of nine or fewer (in figures, graphs, maps, tables, etc.).
- Make no attempt to learn the identity of any person or establishment included in these data.
- Make no disclosure or other use of the identity of any person or establishment discovered inadvertently and advise the NCHS Confidentiality Officer of any such discovery.

Confidentiality Officer
National Center for Health Statistics
3311 Toledo Road
Hyattsville, MD 20782
Telephone 888-642-4159
Email: nchsconfidentiality@cdc.gov

Sanctions for Violating Rules:

Researchers who violate the terms of the data use restrictions will lose access to WONDER and their sponsors and institutions will be notified. Researchers who are suspected of violating the rules may be prevented from using WONDER until an investigation can be completed. Deliberately making a false statement in any matter within the jurisdiction of any department or agency of the Federal government violates 18 USC 1001 and is punishable by a fine of up to $10,000 or up to 5 years in prison, or both.

By clicking the "I Agree" button ***I signify that I will abide by the terms of data use stated above*** *and understand the sanctions and legal penalties for violation of these terms of use.*

I Agree

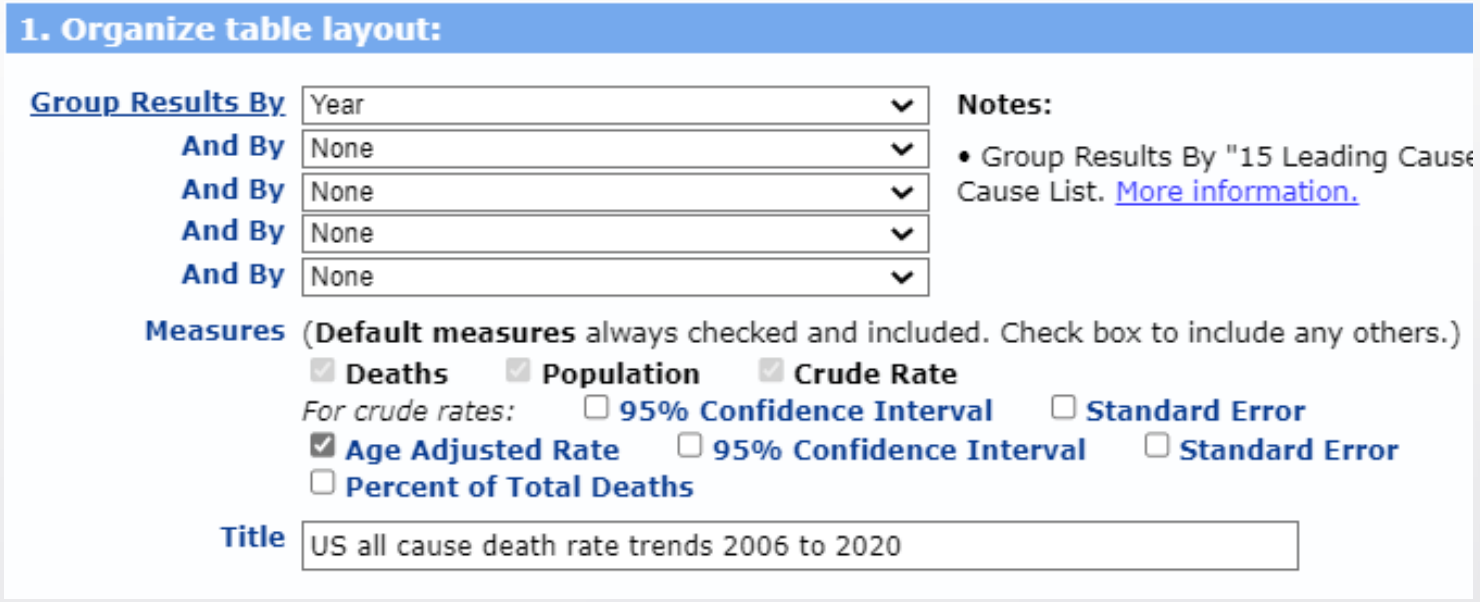
Mortality trend in US males age 45-64

You are then directed to the 7 section request form which will allow us to define the group of interest and obtain death rates

For section 1 you can group results by up to 5 different parameters that are presented as drop downs on each row. For each "Group results by" you have multiple options to select from in a drop down menu including:

- Location
- Demographics
- Timeframe
- Cause of death

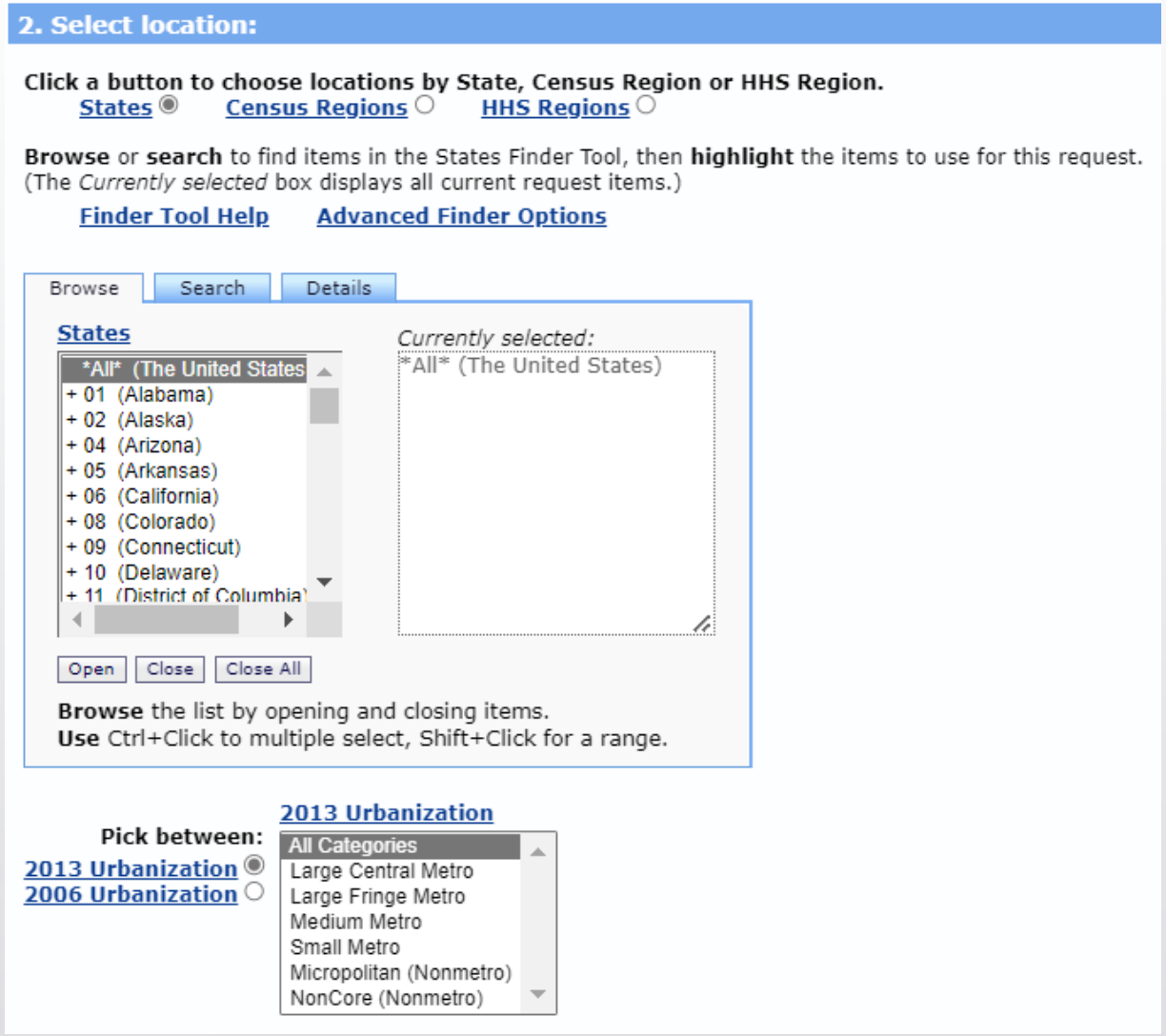
For the question we have raised returning annual age adjusted death rates is all that is required so I have selected "Year" and checked "Age Adjusted Rate". You can also stipulate a title for the output which is useful when running multiple queries against the vital statistics data.



Mortality trend in US males age 45-64

For this request nothing needs to be changed in section 2 because we are looking for death rates across the US.

This section would also allow for a state level analysis and analyses of death rates at the county level and other regional/urbanization levels.

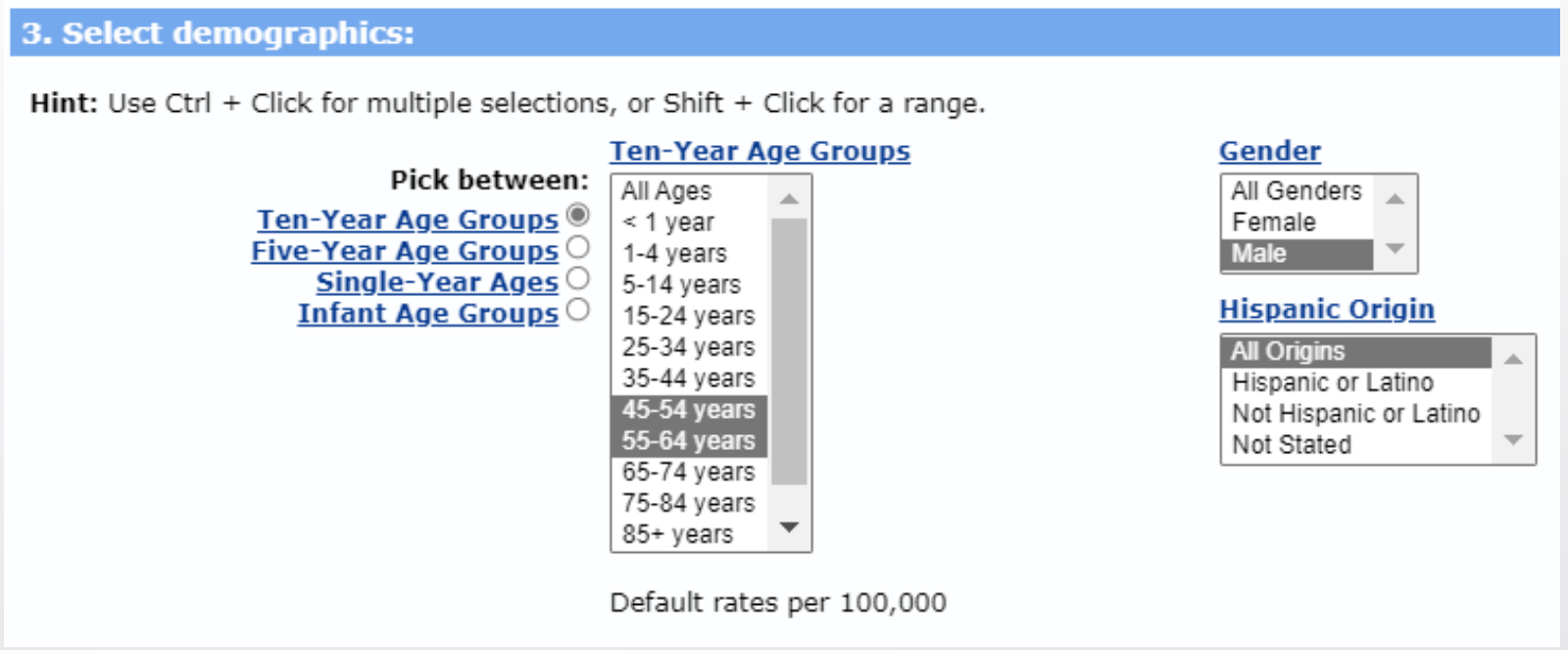


Mortality trend in US males age 45-64

In section 3 you can select the age groups of interest. A broader age range increases available deaths and reduces year to year volatility in the analysis.

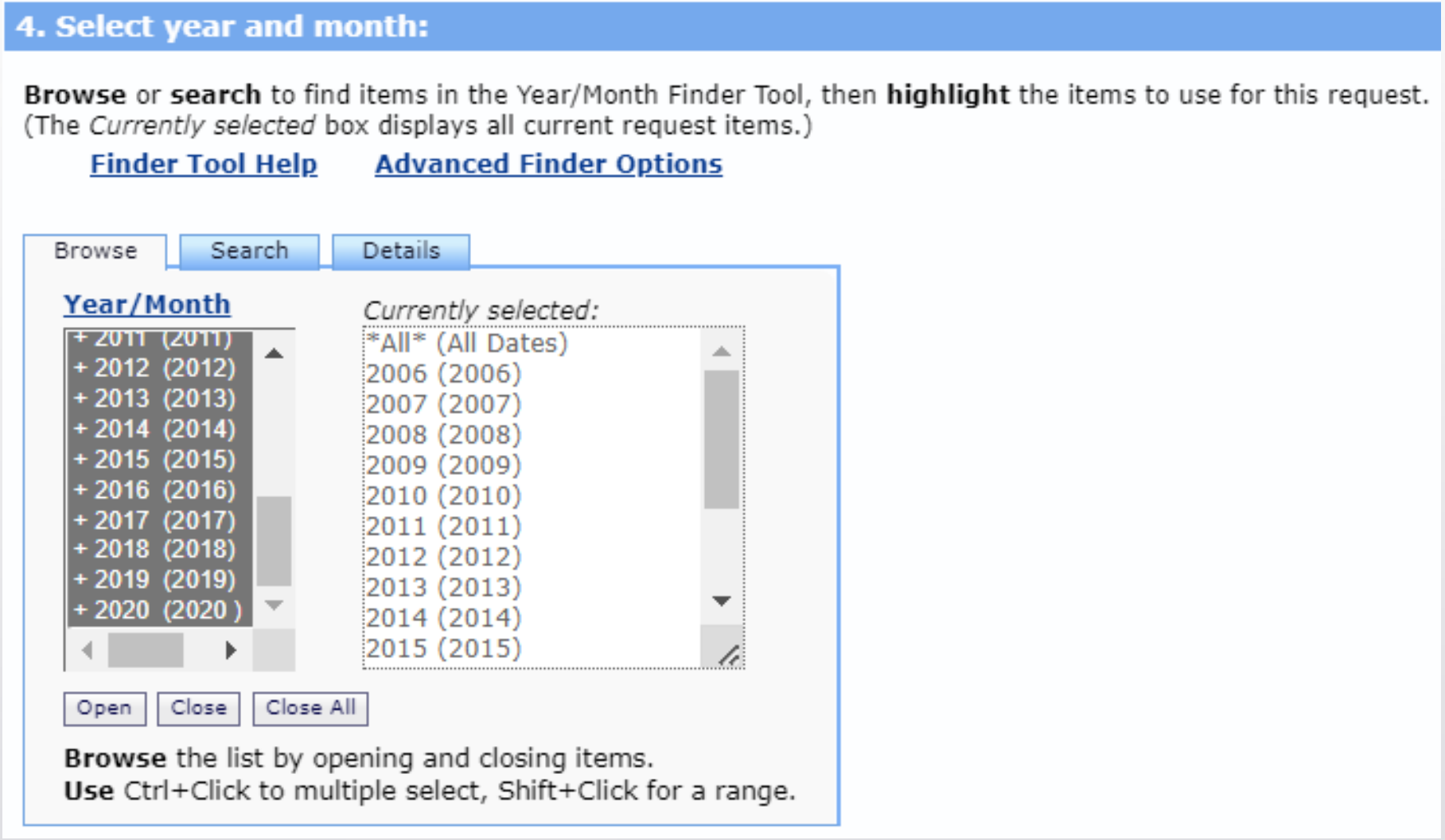
Some of the age group choices on the left do not allow for age adjusted rates which could be a limitation if you are looking at death rates over long periods of time or wide age ranges. The only other parameter to specify for our request is male gender.

The other options in this section are not relevant for trend assessment in insurance business based on regulatory statute.

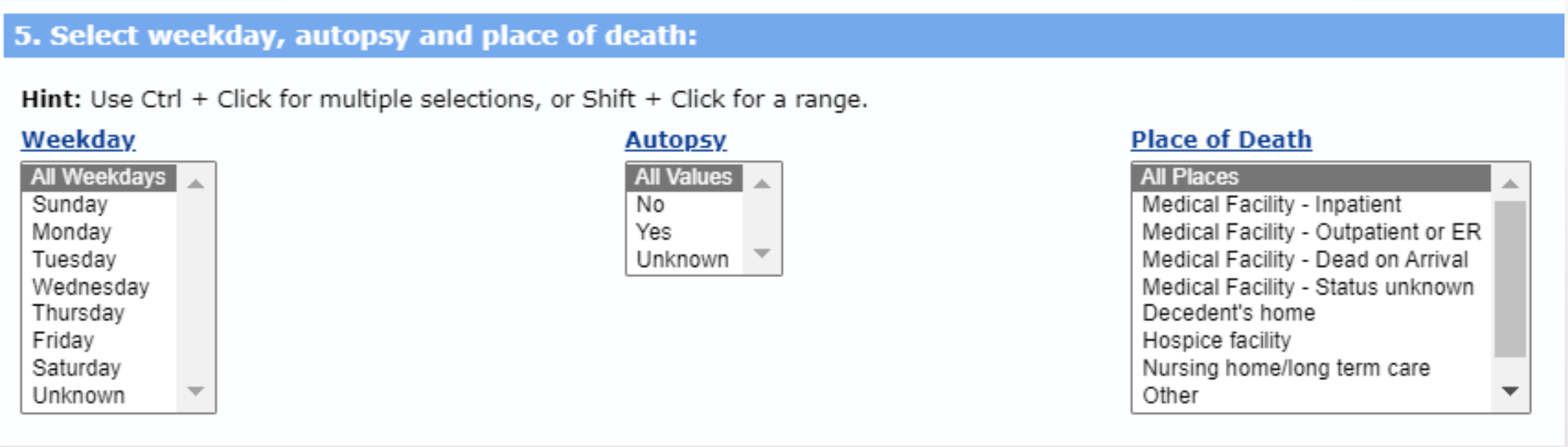


Mortality trend in US males age 45-64

In section 4 select the years for death rates to be returned. In this section its also possible to select individual months but for most trend analyses annual death rates are preferred.



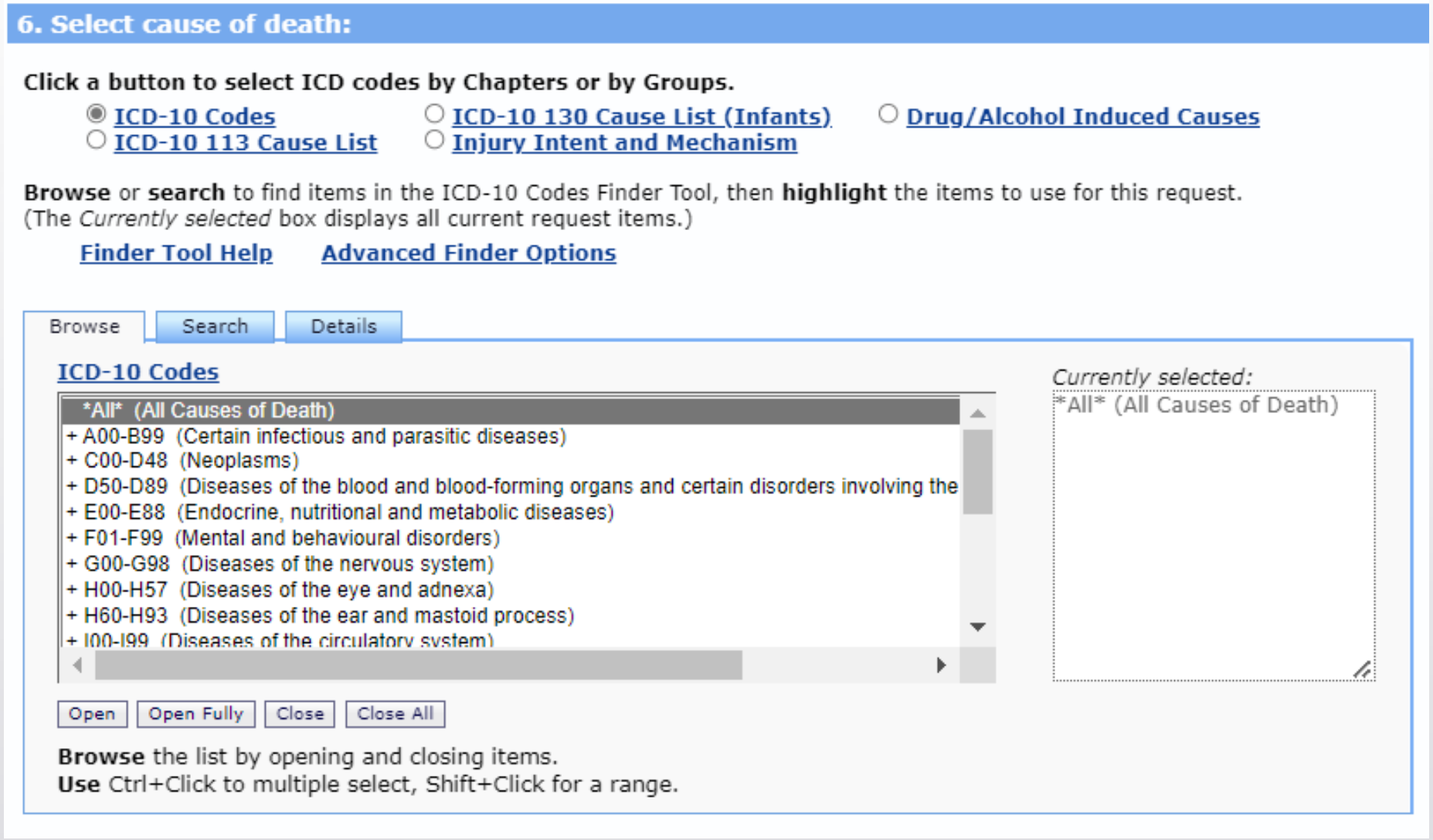
Mortality trend in US males age 45-64



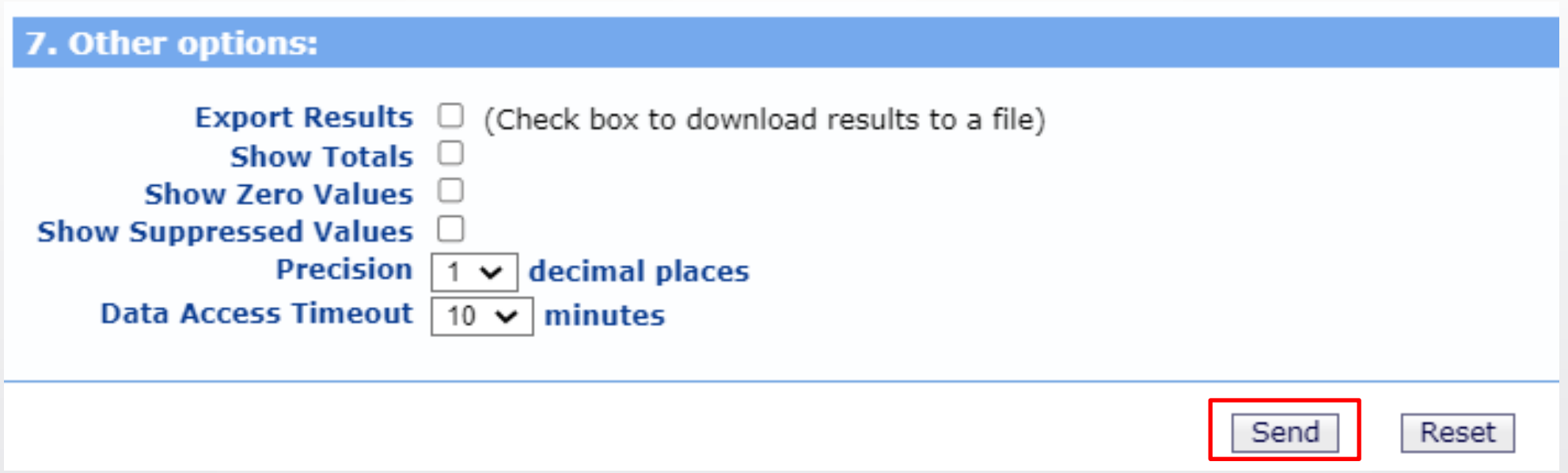
For this request no changes are required to be made in Section 5.

Mortality trend in US males age 45-64

For this request no changes are required to be made in Section 6 either as this is an assessment of mortality trend across all causes. One can see that its possible to obtain information on individual ICD categories or individual ICD codes depending on the needs of the analysis you are performing.



Mortality trend in US males age 45-64



Death rates per 100,000 will be returned when the query is run. Based on the age range for this analysis one decimal point is sufficient. For trend analysis you can deselect the Show Totals checkbox. The other options have more relevance when looking at younger age ranges or individual causes of death where its possible that some years in a time series analysis of death rates might have few deaths.

After verifying your choices click the Send button.

Mortality trend in US males age 45-64: results

On the results tab all cause crude and age adjusted death rates for individuals age 45-64 in the years stipulated are returned.

US all cause death rate trends 2006 to 2020

Deaths occurring through 2020

Request Form | Results | Map | Chart | About

Underlying Cause of Death Data | Dataset Documentation | Other Data Access | Help for Results | Printing Tips | Help with Exports | Save | Export | Reset

Quick Options | More Options | Top | Notes | Citation | Query Criteria

Year	Deaths	Population	Crude Rate Per 100,000	Age Adjusted Rate Per 100,000
2006	284,159	36,672,643	774.9	759.9
2007	288,074	37,581,740	766.5	748.5
2008	294,588	38,338,211	768.4	747.6
2009	298,962	39,145,293	763.7	739.6
2010	301,313	39,743,507	758.1	729.7
2011	308,350	40,377,452	763.7	728.8
2012	310,165	40,409,764	767.5	728.4
2013	314,322	40,525,839	775.6	731.6
2014	318,575	40,746,926	781.8	732.9
2015	323,173	41,013,523	788.0	734.6
2016	327,470	41,105,177	796.7	739.2
2017	329,139	41,164,160	799.6	738.4
2018	329,303	40,940,065	804.4	738.2
2019	326,772	40,671,185	803.4	734.3
2020	390,971	40,414,126	967.4	885.1

Top | Options | Notes | Citation | Query Criteria

Mortality trend in US males age 45-64: results

Query Criteria:

Title:	US all cause death rate trends 2006 to 2020
Gender:	Male
Ten-Year Age Groups:	45-54 years; 55-64 years
Year/Month:	2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017; 2018; 2019; 2020
Group By:	Year
Show Totals:	False
Show Zero Values:	False
Show Suppressed:	False
Standard Population:	2000 U.S. Std. Population
Calculate Rates Per:	100,000
Rate Options:	Default intercensal populations for years 2001-2009 (except Infant Age Groups)

At the bottom of the results page verify that the query criteria applied to the data matches what you wanted your inputs to be. If not, you can toggle back to the results page, make an update to the query criteria and rerun the analysis.

Mortality trend in US males age 45-64: results

We can quantify the rate of change in death rates by calculating a geometric average annual rate of mortality change.

$$1 - \left(\frac{q_x^{CY}}{q_x^{CY-n}} \right)^{\left(\frac{1}{n}\right)}$$

Year	Age adjusted death rate per 100K	Death rate
2006	759.9	0.007599
2007	748.5	0.007485
2008	747.6	0.007476
2009	739.6	0.007396
2010	729.7	0.007297
2011	728.8	0.007288
2012	728.4	0.007284
2013	731.6	0.007316
2014	732.9	0.007329
2015	734.6	0.007346
2016	739.2	0.007392
2017	738.4	0.007384
2018	738.2	0.007382
2019	734.3	0.007343
2020	885.1	0.008851

=1-(POWER((0.008851/0.007599),1/14))
=1-(POWER((1.164759),1/14))
-1.10%

This is the geometric average annual change in death rate. It's negative because of the significant influence of the final interval in the series.

Negative rates represent mortality disimprovement, positive would represent mortality improvement.

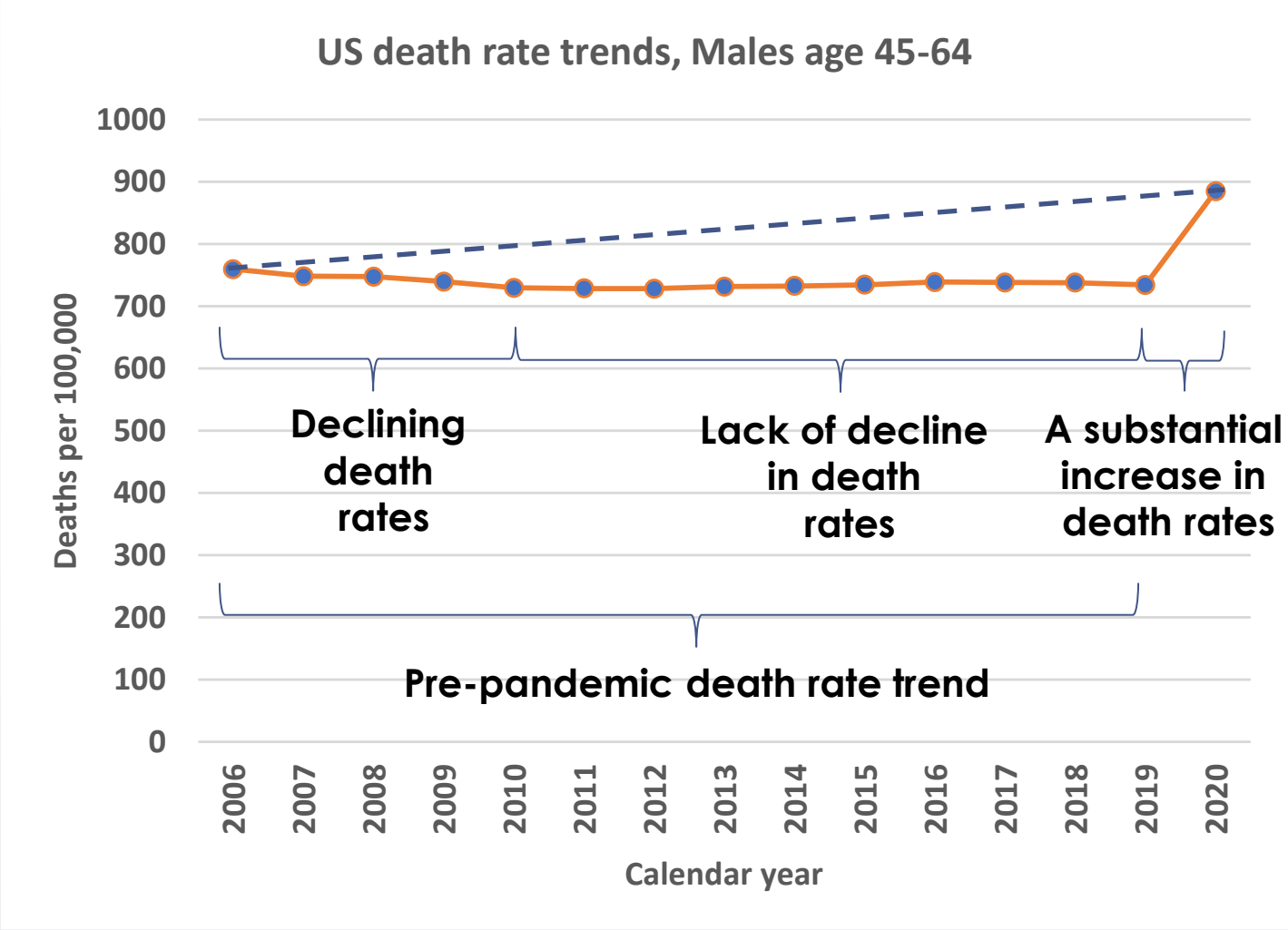
Mortality trend in US males age 45-64: results

Plotting the calendar year death rates provides an opportunity to visualize any patterns in annual death rates that emerge over time.

Does this -1.10% geometric average annual change in death rates adequately describe what happened to death rates over this period?

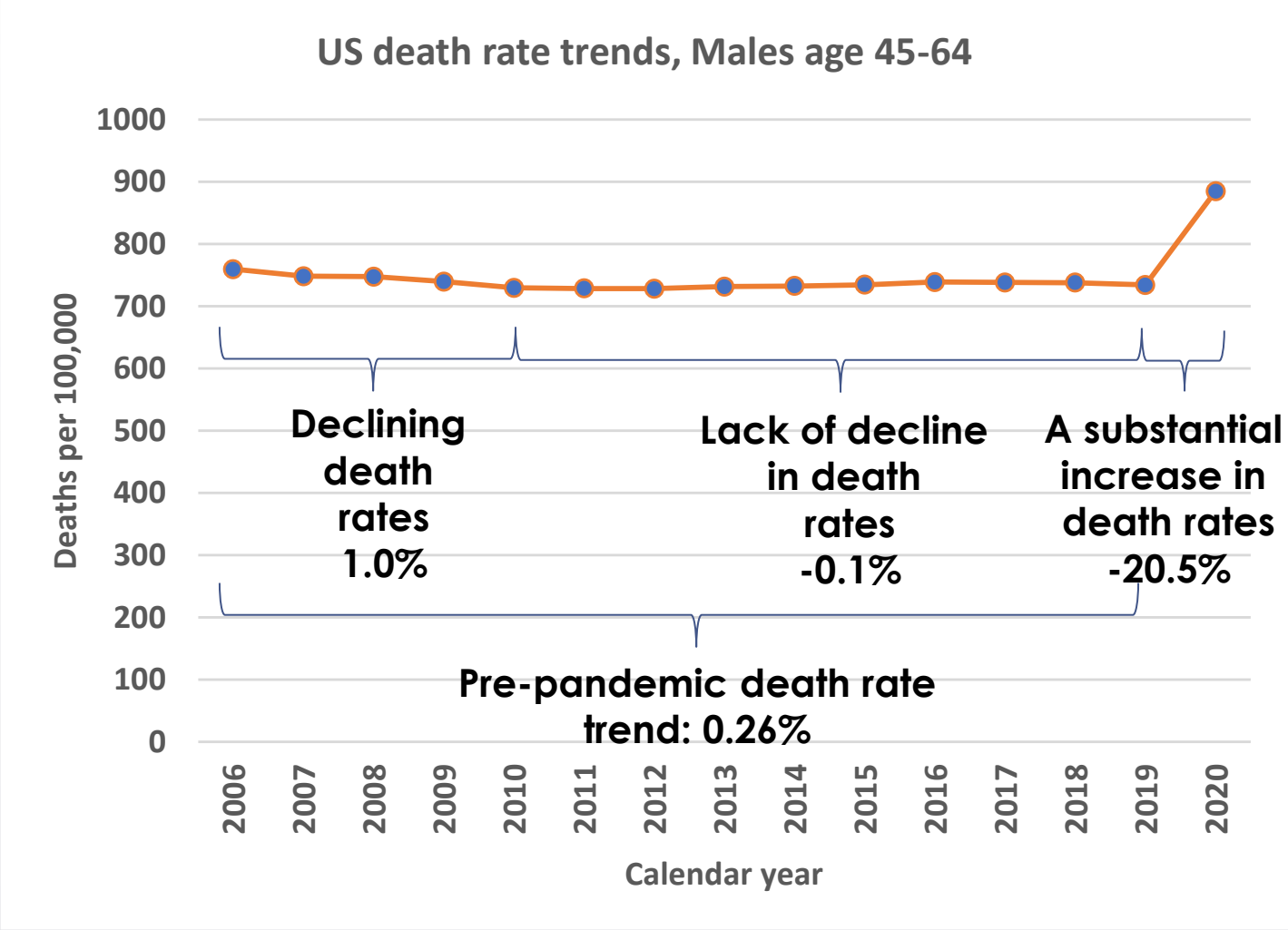
What patterns in the death rates over time do you see?

Using the same formula we can calculate the geometric average annual death rates for each of these additional intervals.



Mortality trend in US males age 45-64: results

Very different rates of death rate change apply to these sub periods.



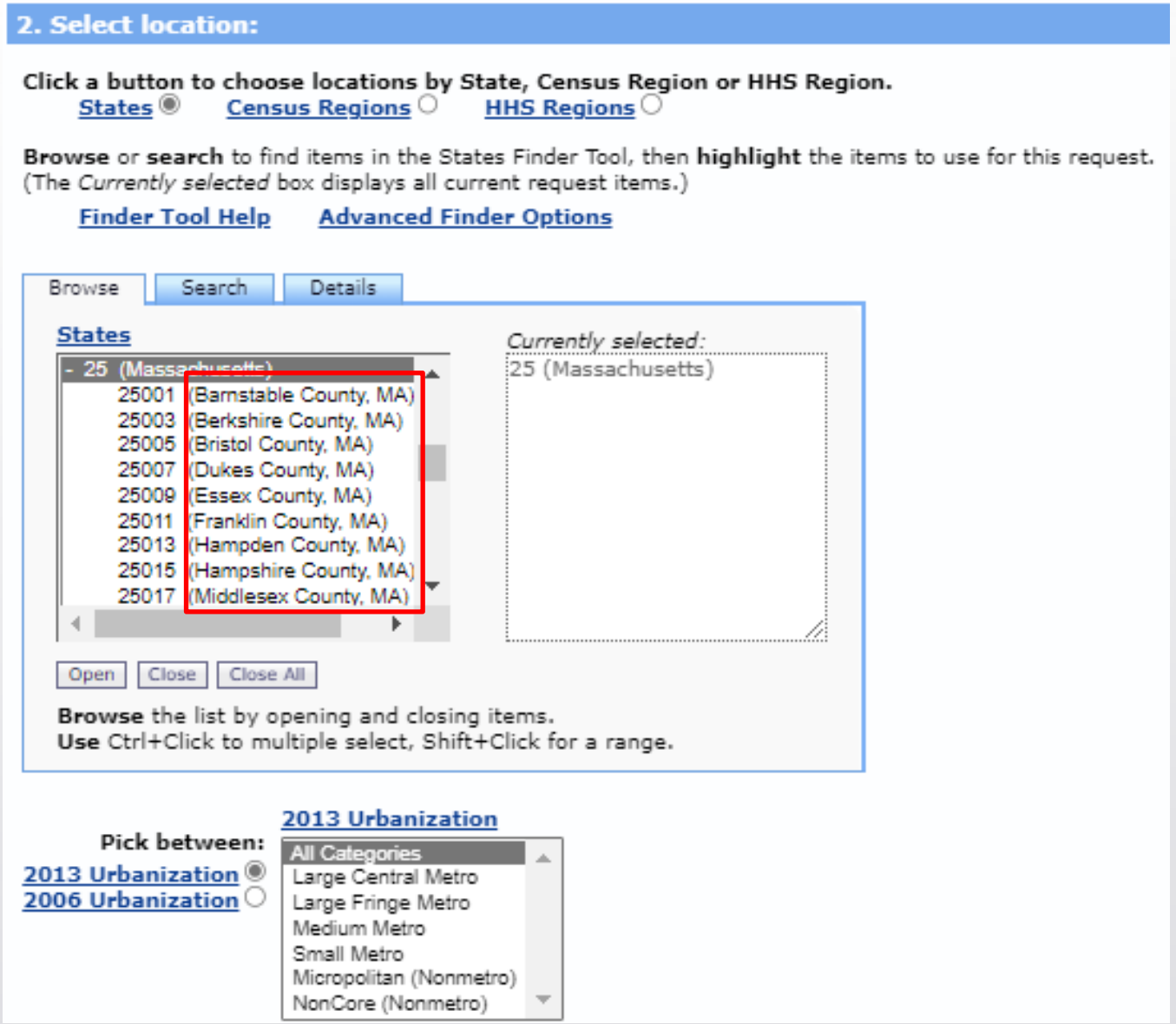
Practical examples: Continued

- Quantify US mortality trend for males age 45-64 over the past 15 years.
- Determine whether high per capita income influences the trend you observed above, where a high per capita income group might be more reflective of trend observed in insured groups.

What measures do we have available in WONDER that would allow us to define a subgroup that might be more representative of insured?

County level analysis

WONDER allows you to do an analysis of death rate trends at the county level. There is a wide variety of data collected at the county level that could be used to define a subset of counties with characteristics that could be more similar to certain insured applicant groups.



Potential stratifying factors to consider in county level data

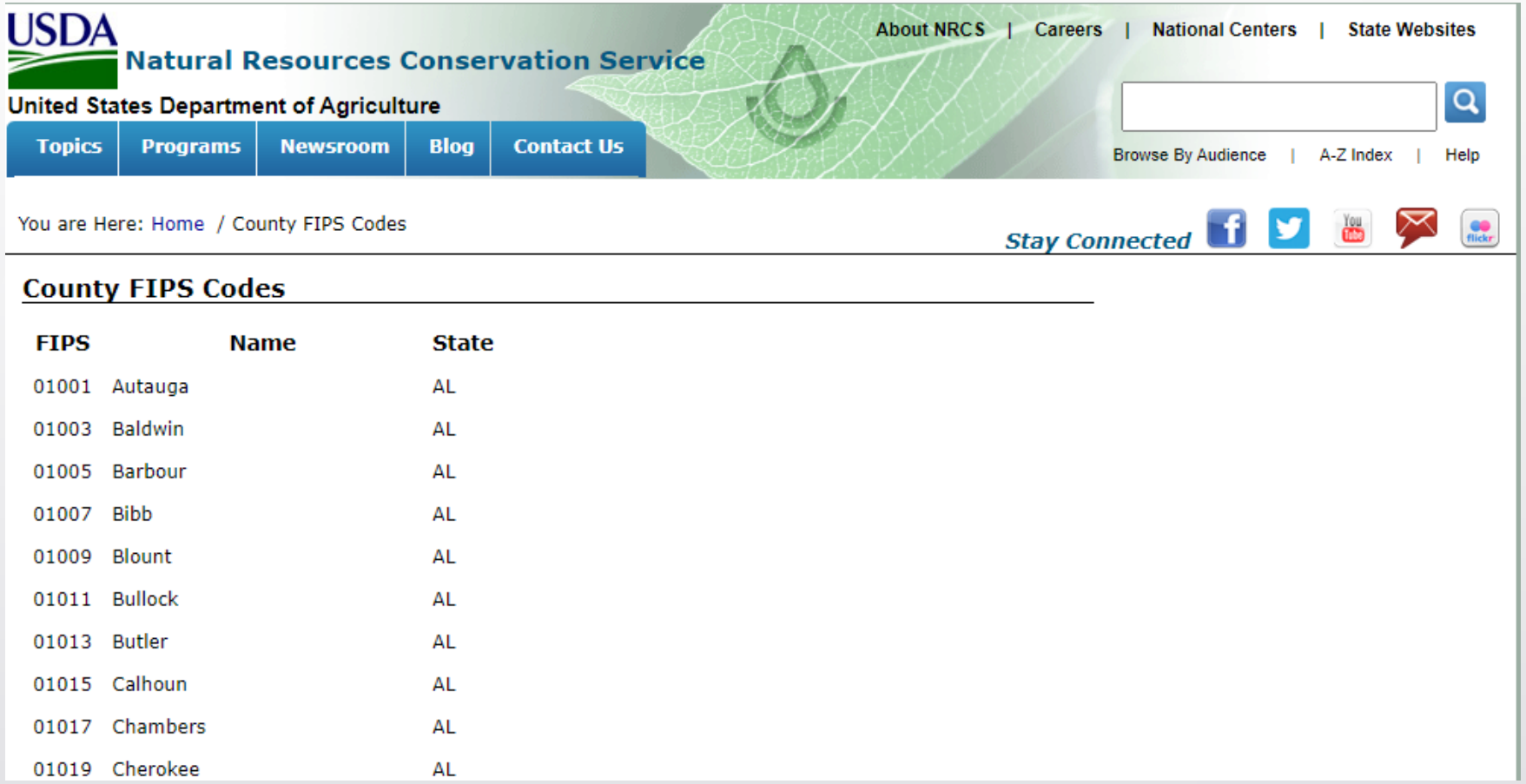
- SES measures (PCI)
- Education
- Depravation measures
- Other sociodemographic and health measures

Many applicants purchasing voluntary insurance covers are more likely to be employed have above average levels of income and potentially better access to health care and have better underlying health status.

Let's consider defining a subset of counties with higher per capita income to see what effect that has on observed death rate trends.

Merging FIPS codes to PCI and county population size

- **Federal Information Processing Standard (FIPS codes): numeric value assigned to counties. There are different FIPS code levels for different levels of aggregation (county vs state).**
- High PCI (available from multiple sources)
- County size (also available from multiple sources). Use county size to determine when a credible population subset for analysis has been defined.



County FIPS Codes (usda.gov)

Merging FIPS codes to PCI and county population size

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Table 1. Per Capita Personal Income, by County, 2018–2020

	Per capita personal income[1]				Percent change from preceding period		
	Dollars			Rank in state	Percent change		Rank in state
	2018	2019	2020	2020	2019	2020	2020
United States	**54,098**	**56,047**	**59,510**	--	**3.6**	**6.2**	--
Alabama	**42,328**	**43,996**	**46,479**	--	**3.9**	**5.6**	--
Autauga	42,931	44,368	46,814	9	3.3	5.5	50
Baldwin	46,905	48,270	50,953	4	2.9	5.6	48
Barbour	34,064	35,572	37,850	49	4.4	6.4	35
Bibb	30,250	31,540	34,300	66	4.3	8.8	14
Blount	35,905	36,969	38,808	36	3.0	5.0	59
Bullock	26,841	28,136	31,944	67	4.8	13.5	1
Butler	35,932	38,073	39,988	34	6.0	5.0	56
Calhoun	36,482	37,708	40,195	30	3.4	6.6	32
Chambers	34,055	36,110	38,508	38	6.0	6.6	31
Cherokee	35,647	36,381	37,869	48	2.1	4.1	62
Chilton	34,982	36,471	38,778	37	4.3	6.3	37
Choctaw	38,200	39,097	42,231	22	2.3	8.0	20
Clarke	35,437	37,061	40,822	26	4.6	10.1	8
Clay	33,131	34,185	37,179	53	3.2	8.8	13
Cleburne	35,668	35,905	37,734	51	0.7	5.1	54
Coffee	42,176	43,319	45,262	11	2.7	4.5	60
Colbert	37,601	38,860	41,941	23	3.3	7.9	21
Conecuh	32,588	33,596	36,908	56	3.1	9.9	10
Coosa	31,344	32,548	34,683	65	3.8	6.6	34

Personal Income by County and Metropolitan Area, 2020 | U.S. Bureau of Economic Analysis (BEA)

Merging FIPS codes to PCI and county population size

- Federal Information Processing Standard (FIPS codes): numeric value assigned to counties. There are different FIPS code levels for different levels of aggregation (county vs state).
- High PCI (available from multiple sources)
- **County size (also available from multiple sources). Use county size to determine when a credible population subset for analysis has been defined.**

Annual Estimates of the Resident Population for Counties in the United States: April 1, 2020 to July 1, 2021

Geographic Area	April 1, 2020 Estimates Base	Population Estimate (as of July 1)	
		2020	2021
United States	**331,449,281**	**331,501,080**	**331,893,745**
Autauga County, Alabama	58,805	58,877	59,095
Baldwin County, Alabama	231,767	233,140	239,294
Barbour County, Alabama	25,223	25,180	24,964
Bibb County, Alabama	22,293	22,223	22,477
Blount County, Alabama	59,134	59,081	59,041
Bullock County, Alabama	10,357	10,309	10,320
Butler County, Alabama	19,051	19,045	18,884
Calhoun County, Alabama	116,441	116,266	115,972
Chambers County, Alabama	34,772	34,678	34,541
Cherokee County, Alabama	24,971	24,958	24,996
Chilton County, Alabama	45,014	45,024	45,274
Choctaw County, Alabama	12,665	12,619	12,533
Clarke County, Alabama	23,087	22,995	22,760
Clay County, Alabama	14,236	14,193	14,190
Cleburne County, Alabama	15,056	15,035	15,103
Coffee County, Alabama	53,465	53,565	54,174
Colbert County, Alabama	57,227	57,236	57,474
Conecuh County, Alabama	11,597	11,552	11,328
Coosa County, Alabama	10,387	10,383	10,450
Covington County, Alabama	37,570	37,469	37,524
Crenshaw County, Alabama	13,194	13,157	13,083
Cullman County, Alabama	87,866	88,044	89,496

County Population Totals: 2020-2021 (census.gov)

Merging FIPS codes to PCI and county population size

- To provide a credible number of deaths for annual death rate determinations consider using a 10% population sample.
- Counties with a per capita income of $80,420 or higher were included.

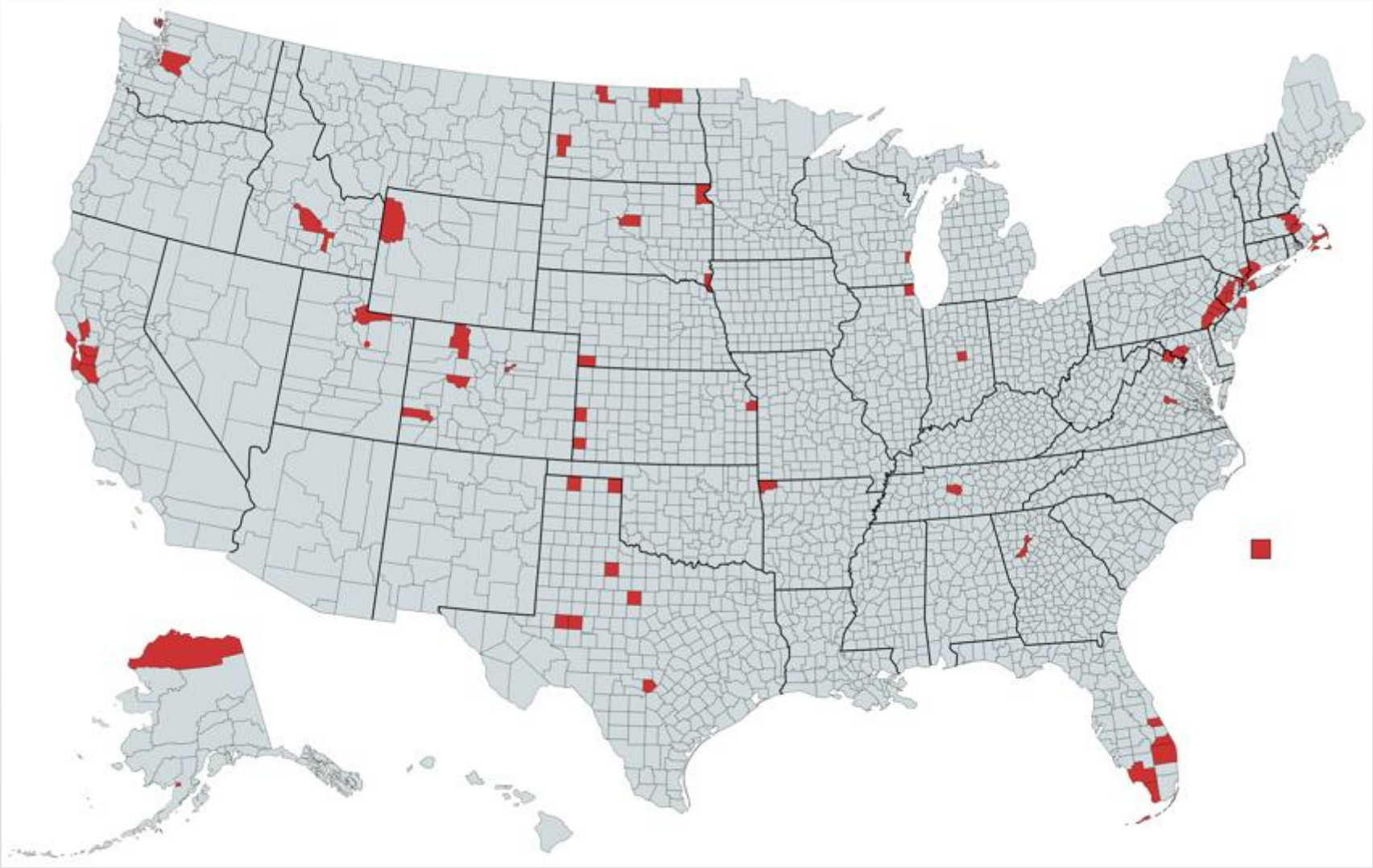
Note that county level PCI does not mean everyone in the county has a per-capita income of the stated value. It's an average value, with some individuals above and below that value.

	FIPS code	County	State	**PCI 2020**	Pop estimate
1	56039	Teton	WY	$220,645	23,331
2	36061	New York	NY	$191,220	1,694,251
3	49043	Summit	UT	$156,537	42,357
4	08097	Pitkin	CO	$155,067	17,358
5	02060	Bristol Bay	AK	$152,678	844
6	06041	Marin	CA	$145,575	262,321
7	06075	San Francisco	CA	$144,818	873,965
8	06081	San Mateo	CA	$141,841	764,442
9	48329	Midland	TX	$126,631	169,983
10	06085	Santa Clara	CA	$123,661	1,936,259
		(Break)			
67	38007	Billings	ND	$ 82,466	945
68	06055	Napa	CA	$ 82,408	138,019
69	24027	Howard	MD	$ 81,969	332,317
70	53055	San Juan	WA	$ 81,858	17,788
71	48269	King	TX	$ 81,541	265
72	20091	Johnson	KS	$ 80,681	609,863
73	42017	Bucks	PA	$ 80,627	646,538
74	38075	Renville	ND	$ 80,431	2,282
75	18057	Hamilton	IN	$ 80,426	347,467
76	25001	Barnstable	MA	$ 80,420	228,996
				Total	33,147,223

High PCI subset: Geographic characteristics

Observations

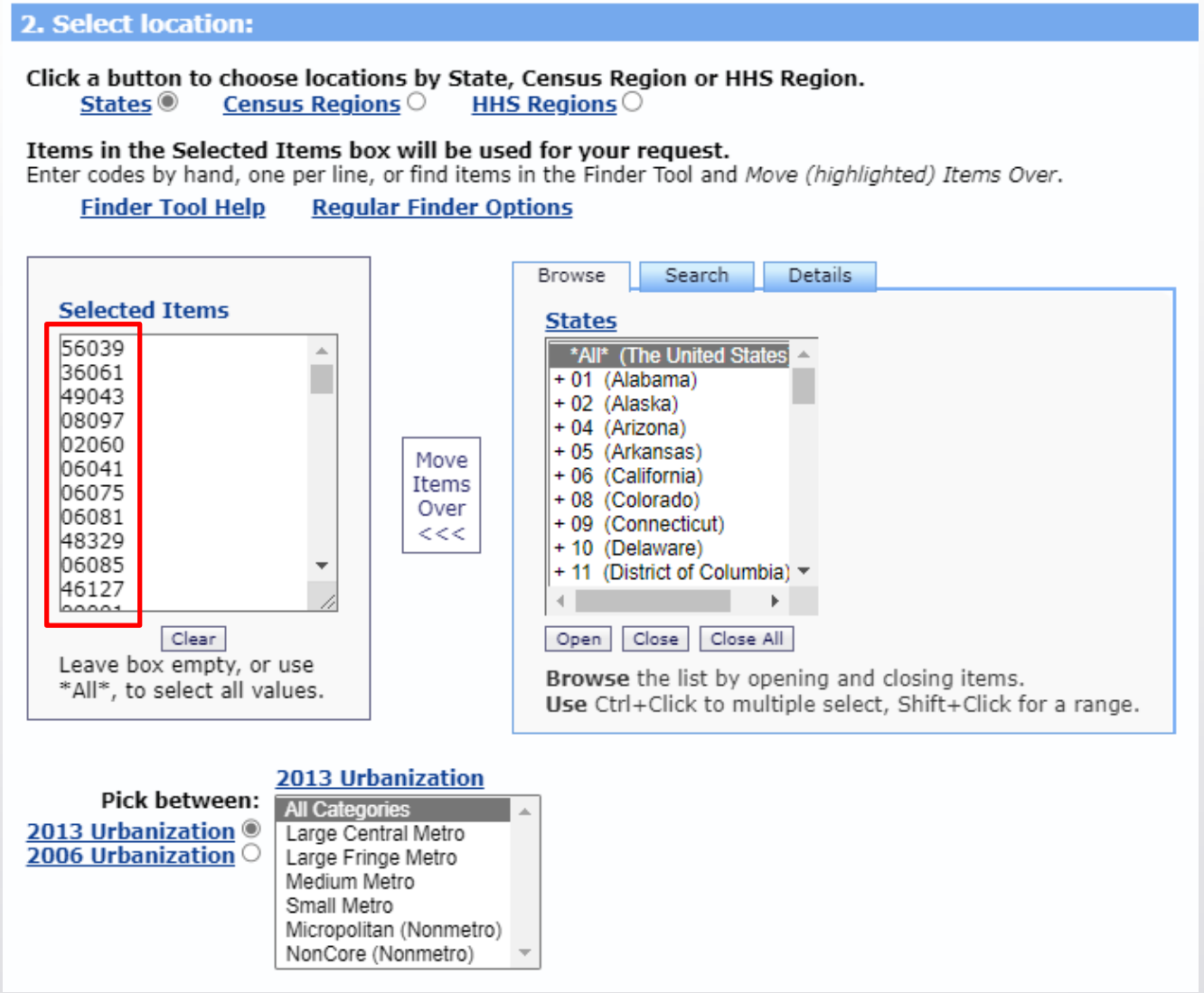
- Higher PCI counties are generally concentrated on the east and west coast an in (or adjacent to) major metropolitan areas.



County level analysis

Once you have identified the FIPS codes for the counties that meet your selection criteria you can use the advanced finder option in section 2 to paste that list of codes into the query box.

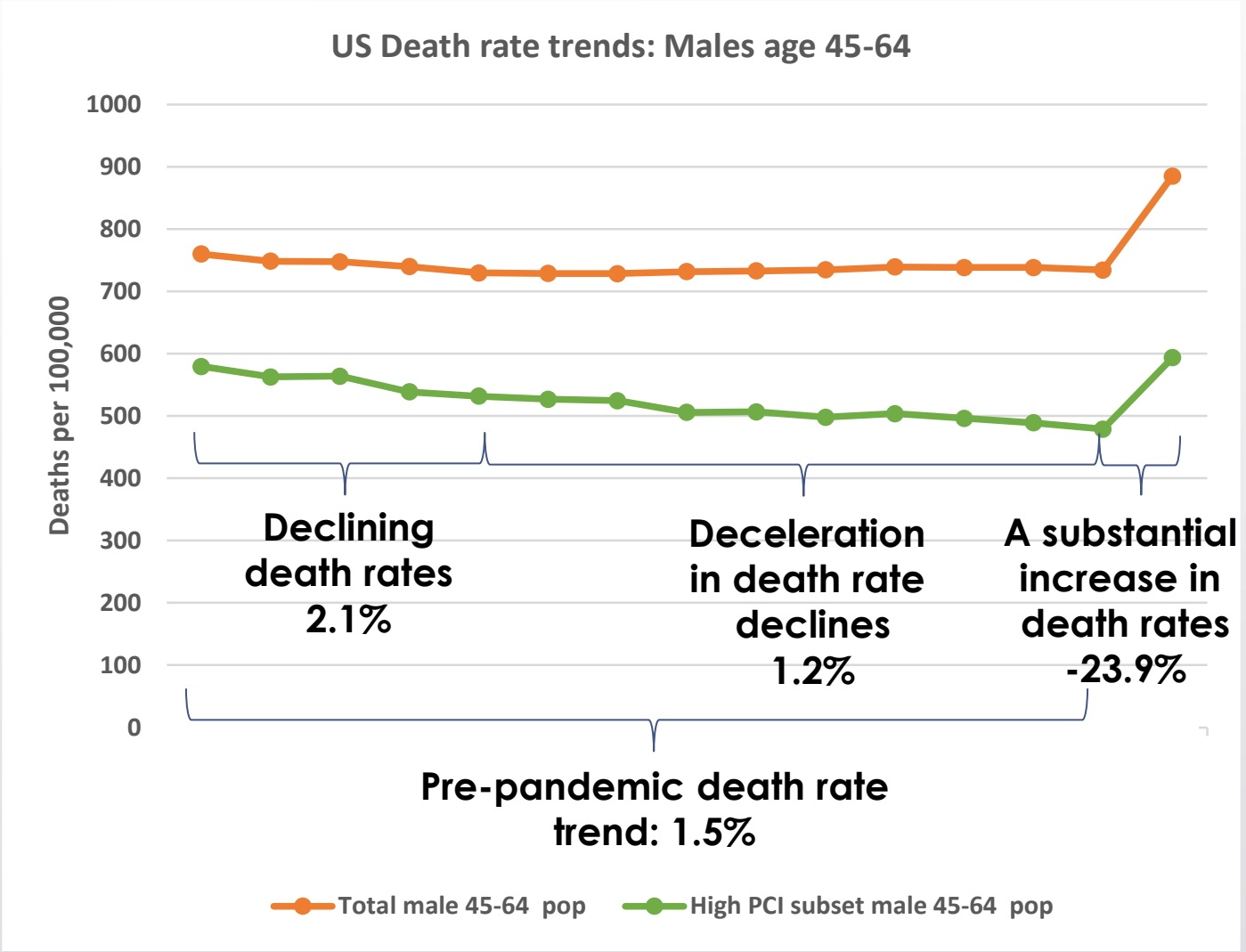
All other inputs on the request form to obtain deaths rates are the same. After entering your criteria and verifying the entries click the "Send" button to generate your new list of calendar year death rates for the high PCI male age 45-64 year old age group.



Mortality trend in US males age 45-64: results

Observations

- Death rates are lower for the High PCI group.
- The pattern of death rate decline is different. There is less deceleration in the 2010-2019 period.
- The pandemic also affected death rates in this group.



Mortality trend in US males age 45-64: results

Observations continued

- Socioeconomic status influences not only mortality rates but mortality trend. Risk factor / disease burden and access to health care are factors that may contribute to differences between total population and high PCI groups.
- Its notable that whatever factors allowed for higher rates of mortality decline in the High PCI group apparently did not have a significant influence on 2020 pandemic excess mortality within this age group.
- Depending on the intensity of underwriting within a product mortality trends observed in the overall or a subset of the US population could serve as one benchmark in considering the magnitude and direction of insured lives mortality trend.

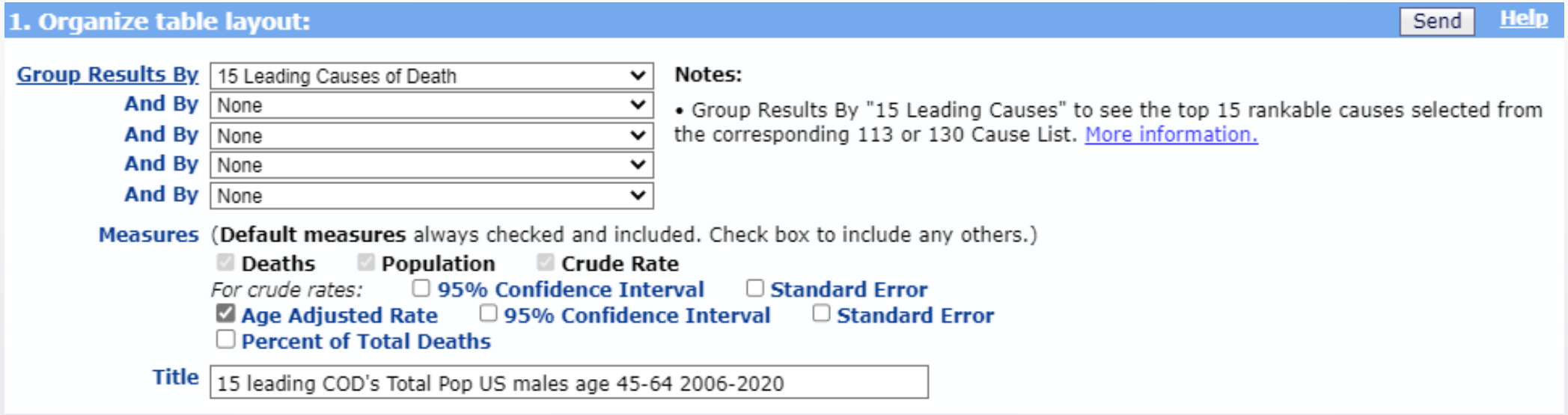
Period of observation		Total pop Males 45-65	High PCI Males 45-65
Period of higher death rate decline	**2006-2010**	-1.0%	2.1%
	2010-2019	-0.1%	1.2%
Pandemic	**2019-2020**	-20.5%	-23.9%
Pre pandemic period	**2006-2019**	0.3%	1.5%
Full period	**2006-2020**	-1.1%	-0.2%

So, what's the relevance to insured?

In a broader age range and compared to average claim levels in 2017-19 excess claims for ages 50 to 69 in Q2 –Q4 2020 ranged from 7% to 20%.

U.S. Individual Life COVID-19 Reported Claims Analysis, Fourth Quarter, 2021 Update (soa.org)

Cause specific mortality trend:



Understanding what causes of death influence trends in all cause mortality is important, particularly with regards to the permeability of underwriting for diseases linked to those causes,

There are 2 ways to obtain cause specific death rates in CDC WONDER. In section one under "Group Results By" you can choose to look at cause specific death rates in a number of ways including:

- 15 leading causes of death
- ICD chapter or subchapter
- ICD-113 cause list.

You can also select individual or multiple COD categories or specific COD's within a category in section 6 of the request form.

Cause specific mortality trend:

Selecting the 15 leading causes of death in section 1 of the request form could be a useful starting point to understand major drivers of all cause mortality trend within this gender and age group. Note that you cannot add another grouping result such as years when requesting a 15 leading COD report.

Underlying Cause of Death, 1999-2020 Results

15 leading COD's Total Pop US males age 45-64 2006-2020

Deaths occurring through 2020

Request Form | Results | Map | Chart | About

Underlying Cause of Death Data | Dataset Documentation | Other Data Access | Help for Results | Printing Tips | Help with Exports

Save | Export | Reset

Quick Options | More Options

Top | Notes | Citation | Query Criteria

Messages:

▸ When you group results by 15 Leading Causes, results are initially ordered by Death counts; also, total rows, zero rows, suppressed rows, and Percent of Total are not available. Click any green up/down arrow to change the order. More information.

15 Leading Causes of Death	Deaths	Population	Crude Rate Per 100,000	Age Adjusted Rate Per 100,000
#Malignant neoplasms (C00-C97)	1,244,941	598,849,611	207.9	191.5
#Diseases of heart (I00-I09,I11,I13,I20-I51)	1,140,942	598,849,611	190.5	178.9
#Accidents (unintentional injuries) (V01-X59,Y85-Y86)	411,360	598,849,611	68.7	68.8
#Chronic liver disease and cirrhosis (K70,K73-K74)	205,883	598,849,611	34.4	33.2
#Diabetes mellitus (E10-E14)	179,894	598,849,611	30.0	28.1
#Intentional self-harm (suicide) (*U03,X60-X84,Y87.0)	171,448	598,849,611	28.6	28.7
#Chronic lower respiratory diseases (J40-J47)	153,842	598,849,611	25.7	23.2
#Cerebrovascular diseases (I60-I69)	148,282	598,849,611	24.8	23.2
#Nephritis, nephrotic syndrome and nephrosis (N00-N07,N17-N19,N25-N27)	63,677	598,849,611	10.6	9.9
#Septicemia (A40-A41)	61,293	598,849,611	10.2	9.5
#Influenza and pneumonia (J09-J18)	57,795	598,849,611	9.7	9.0
#Viral hepatitis (B15-B19)	49,401	598,849,611	8.2	7.9
#Human immunodeficiency virus (HIV) disease (B20-B24)	48,325	598,849,611	8.1	8.2
#Essential hypertension and hypertensive renal disease (I10,I12,I15)	44,425	598,849,611	7.4	7.0
#COVID-19 (U07.1)	38,382	598,849,611	6.4	6.0

Note: A '#' symbol preceding the label indicates a rankable cause of death. More information.

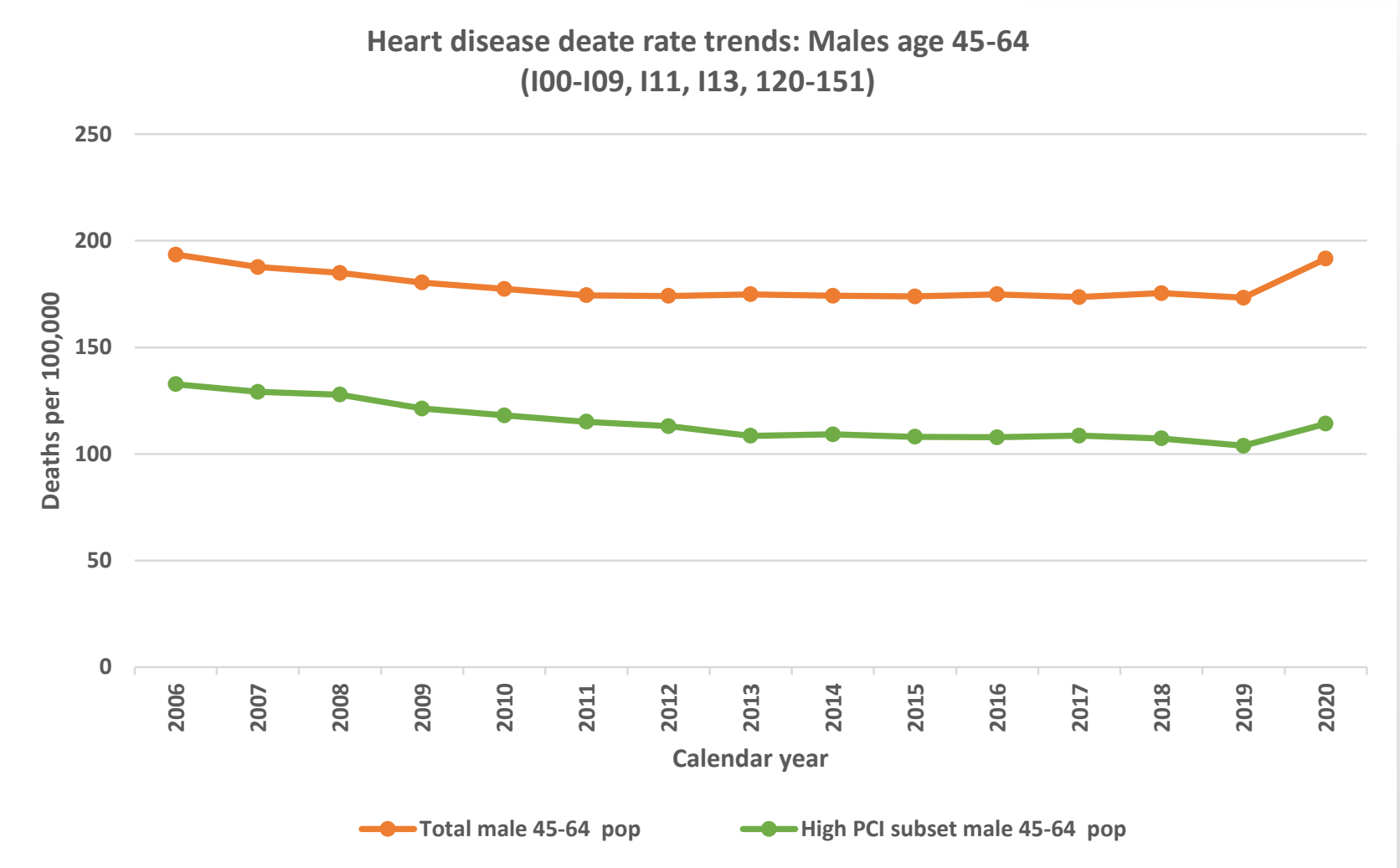
Cause specific mortality trend:

	Proportional comparison		AA Death rate comparison		
	Total male 45-64 pop	High PCI subset male 45-64 pop	Total male 45-64 pop	High PCI subset male 45-64 pop	Ratio High PCI cause specific death rate to total POP cause specific death rate
Malignant neoplasms (C00-C97)	25.6%	27.2%	191.5	143.1	74.7%
Diseases of heart (I00-I09,I11,I13,I20-I51)	23.9%	21.8%	178.9	114.6	64.1%
Accidents (unintentional injuries) (V01-X59,Y85-Y86)	9.2%	9.8%	68.8	51.4	74.7%
Chronic liver disease and cirrhosis (K70,K73-K74)	4.4%	4.3%	33.2	22.7	68.4%
Diabetes mellitus (E10-E14)	3.8%	3.4%	28.1	22.1	78.6%
Intentional self-harm (suicide) (*U03,X60-X84,Y87.0)	3.8%	4.2%	28.7	18.1	63.1%
Chronic lower respiratory diseases (J40-J47)	3.1%	2.0%	23.2	15.6	67.2%
Cerebrovascular diseases (I60-I69)	3.1%	3.0%	23.2	10.6	45.7%
Nephritis, nephrotic syndrome and nephrosis (N00-N07,N17-N19,N25-N27)	1.3%	1.1%	9.9	9.2	92.9%
Septicemia (A40-A41)	1.3%	1.2%	9.5	6.3	66.3%
Influenza and pneumonia (J09-J18)	1.2%	1.2%	9	6.2	68.9%
Viral hepatitis (B15-B19)	1.1%	1.1%	7.9	6	75.9%
Human immunodeficiency virus (HIV) disease (B20-B24)	1.1%	1.8%	8.2	5.8	70.7%
Essential hypertension and hypertensive renal disease (I10,I12,I15)	0.9%	1.0%	7	5.4	77.1%
COVID-19 (U07.1)	0.8%	0.9%	6	4.9	81.7%
All other COD's	15.4%	15.9%	115.4	83.7	72.5%

Cause specific mortality trend example: Heart disease (I00-I09,I11,I13,I20-I51)

Using section 6 of the request form we can obtain annual heart disease death rates for males age 45-64 for the total population and for the high PCI group in two separate queries.

In the graph we see declines in Heart disease death rates thru the early 2010's, deceleration to flattening thru 2018 and a rise in heart disease death rates in 2020. In contrast to the total population the 202 rise in heart disease death rates in 2020 appears to be more modest in the high PCI group compared to what is observed in the total population.



Conclusions

- Increased emphasis on middle market and final expense sales and evolving underwriting methods that rely on less physical evidence collected at the time of underwriting are increasing the mortality diversity of applicants and policyholders.
- By analyzing age group specific major causes of death one can get a sense of emerging trends in key underlying causal drivers of all cause mortality trend and how those cause specific trends vary by SES.
- Mortality trends observed in the overall population and in population subsets may therefore be useful to consider when attempting to quantify more recent mortality trend in insured groups.
- Because of their knowledge of population risk factor and disease burden trends and their knowledge of the strength of underwriting in different insurance products medical directors are a critical resource to pricing teams considering current and future insured mortality trend. CDC WONDER represents an information sources that can help in understanding recent mortality trends in population's that could have similarities to certain applicant pools.

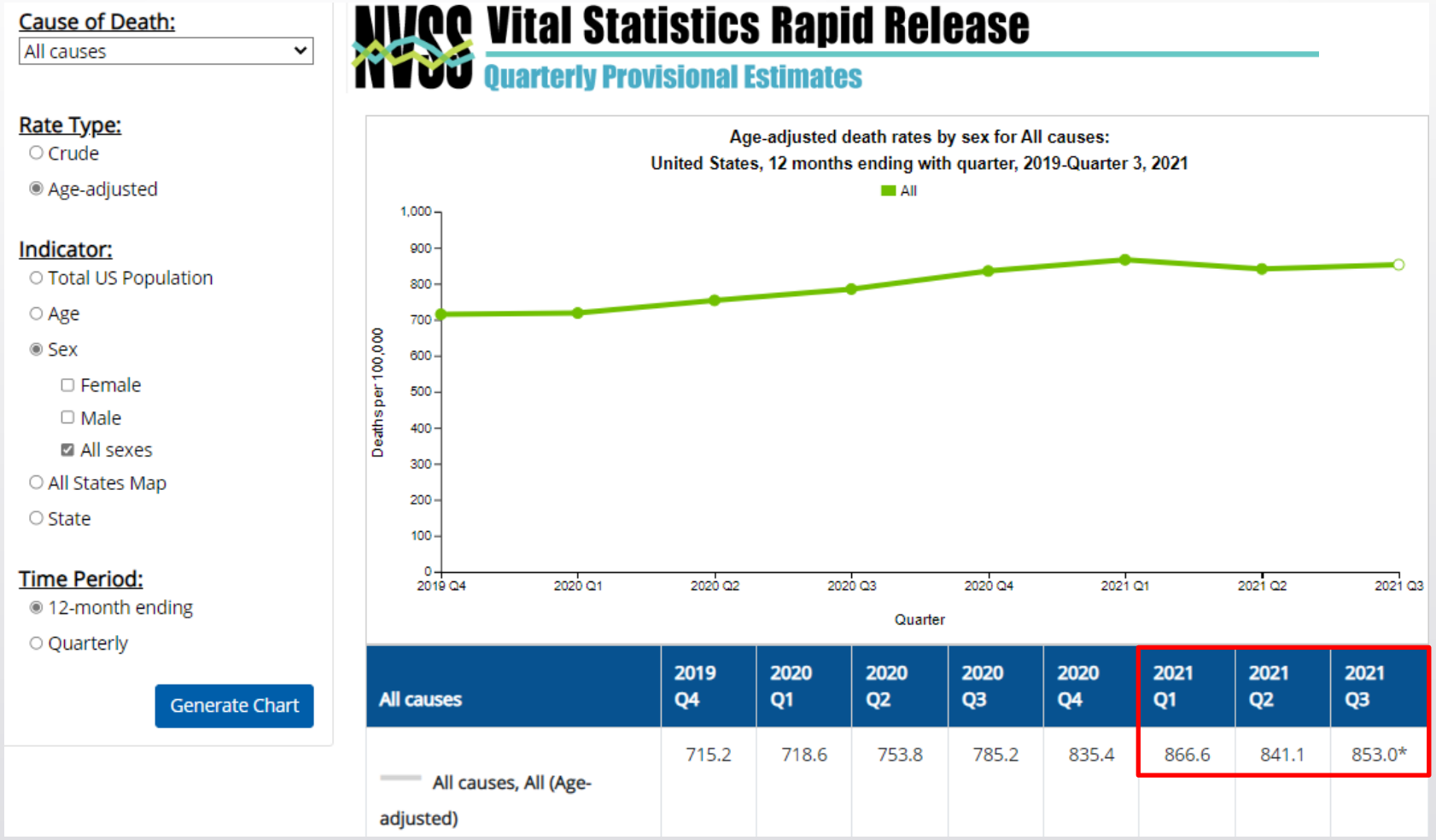
Appendix I: Additional on-line vital statistics resources

National Vital Statistics System Rapid Release

Quantifying the most recent US mortality trend: NVSS Rapid Release

The NVSS rapid release is a "early warning system" on US mortality, giving us insights on all cause and cause specific death rate trends into a portion of the years following what is available in CDC WONDER.

A high PCI county level analysis is not possible at this time with the NVSS system



All causes	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
All causes, All (Age-adjusted)	715.2	718.6	753.8	785.2	835.4	866.6	841.1	853.0*

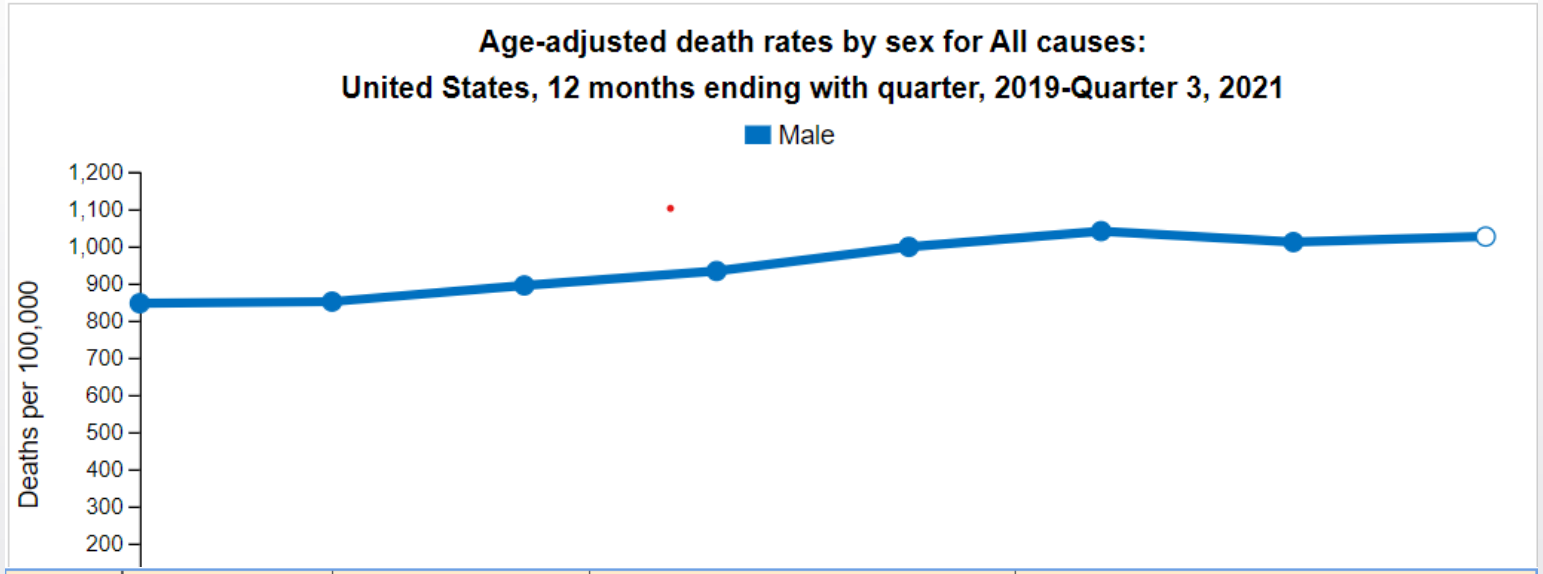
[Products - Vital Statistics Rapid Release - Mortality (cdc.gov)]

Rolling average vs annual death rates

We would anticipate that the Q4 rolling average death rate would be similar to the annual death rates reported in CDC WONDER.

We can see that they are.

NVSS (as of July 2022) gives us 3 more quarters of death rate data compared to what is currently available in CDC WONDER, with the final quarter being provisional.



Year	Deaths	Population	Crude Rate Per 100,000	Age Adjusted Rate Per 100,000
2018	1,458,469	161,128,679	905.2	855.5
2019	1,473,823	161,657,324	911.7	846.7
2020	1,769,884	162,256,202	1,090.8	998.3

All causes	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
All causes, Male (Age-adjusted)	846.7	851.0	894.6	933.4	998.3	1040.8	1011.2	1026.1*

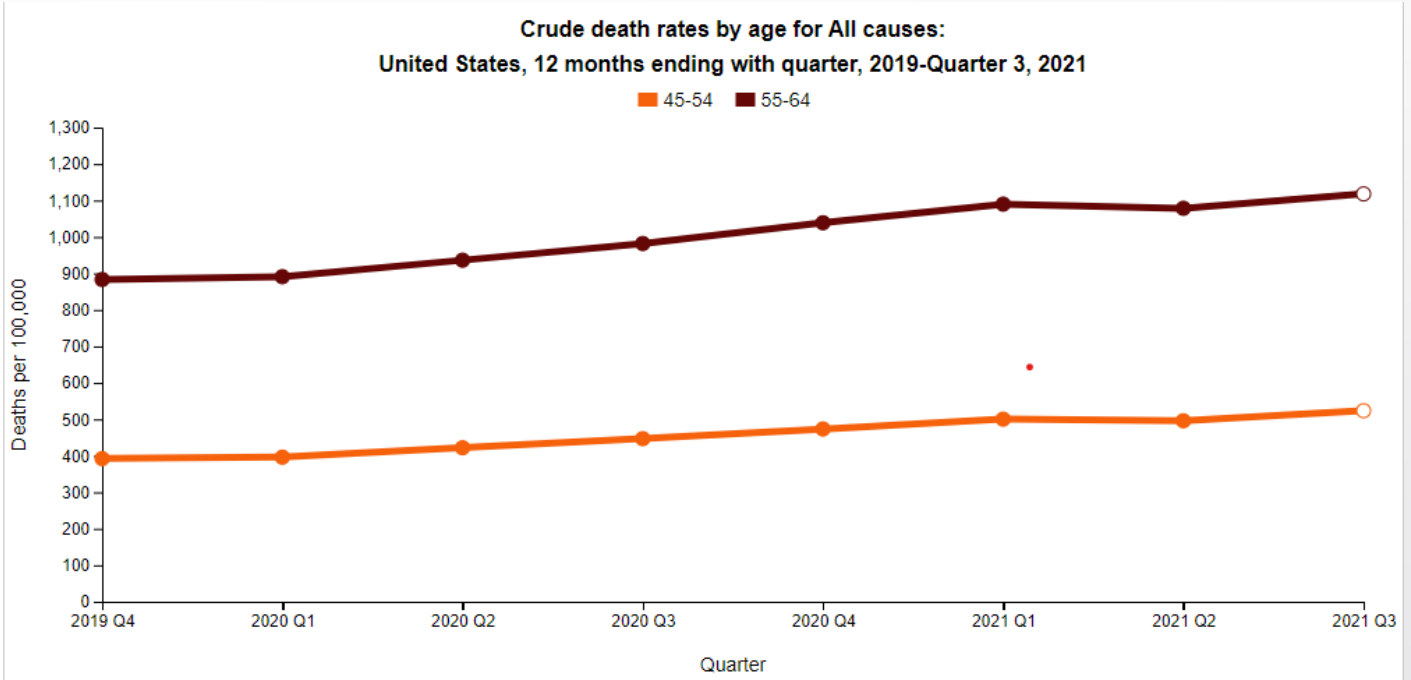
Crude death rates thru Q3 ages 45-54 and 55-64 M+F

Age adjustment is not possible within a single age band. Combining age bands or simultaneously analyzing age band along with gender in NVSS is not available at this time. Therefore these are crude death rates for separate age groups for both genders.

The age adjusted death rate for the M+F 45-64 age group increased from 2019 to 2020 so these sustained increases in crude death rates in the first 3 quarters of 2021 are likely to mean that death rates will continue to be elevated in 2021 at these ages.

Claims ratios also remained elevated in insured groups at these ages in 2021 compared to what was observed in 2017-19.

What is causing these persistent elevations in mortality?



All causes	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
All causes, 45-54 (Crude)	392.4	396.3	422.1	447.0	473.5	500.5	496.0	523.6*
All causes, 55-64 (Crude)	883.3	891.0	936.3	982.0	1038.9	1090.0	1078.6	1118.0*

Cause specific death rates thru Q3 2021, ages 45-54 and 55-64 M+F

Recent death rate trends for multiple COD's or COD categories can be monitored in NVSS including:

Alzheimer's / Parkinson's
Cancer
Chronic liver disease & cirrhosis
COPD
COVID-19
Diabetes
Drug overdose
Falls age 65+
Heart disease / Stroke
HIV
Homicide
Influenza & pneumonia
Kidney disease
Sepsis
Suicide
Accidents

We can't look an individual gender and age group at the same time. Using CDC WONDER we can examine recent death rate trends in Key COD's in the 45-54 and 55-64 year old age ranges separately for males and females combined.

Cause specific death rates thru Q3 2021, ages 45-54 and 55-64 M+F

Recent death rate trends for multiple COD's or COD categories can be monitored in NVSS including:

Alzheimer's / Parkinson's
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Kidney disease
Sepsis
Suicide
Accidents

We can't look an individual gender and age group at the same time. Using CDC wonder we can examine recent death rate trends in Key COD's in the 45-54 and 55-64 year old age ranges separately for males and females combined

Important COD's 2019-2020	45-54	55-64
Cancer	20.0%	27.2%
Heart disese	18.6%	20.8%
Accidents	14.6%	6.6%
COVID-19	4.8%	5.2%
Diabetes	4.0%	4.1%
Liver disease	5.0%	3.7%
COPD	2.0%	4.6%

Cause specific death rates thru Q3 2021, ages 45-54 and 55-64 M+F

Age 45-54	Deaths per 100,000 12 month ending Q4 2020	Q3 2021	% change
Cancer	85.7	83.8*	-2.2%
Heart disese	84.6	85.3*	0.8%
Accidents	68.9	*73.9***	7.3%
COVID-19	42	80.9*	92.6%
Diabetes	18.7	18.7*	0.0%
Liver disease	23.5	25.9*	10.2%
COPD	8.8	7.8*	-11.4%

Age 55-64	Deaths per 100,000 12 month ending Q4 2020	Q3 2021	% change
Cancer	260	257.3*	-1.0%
Heart disese	208.8	210.7*	0.9%
Accidents	68.2	*73.6***	7.9%
COVID-19	99.3	165.1*	66.3%
Diabetes	42.5	43.9*	3.3%
Liver disease	38.1	41.5*	8.9%
COPD	44.4	41.3*	-7.0%

*** Provisional**

**** Provisional Q2 2021**

These COD's represent about 70% of overall deaths in these 2 age bands. Most continued to show elevations in Q3 2021 relative to the full 12 months ending in Q4 2020, which is why all cause mortality on the prior slide remains elevated.