

Changes in Death Rates & Life Expectancy Associated with the COVID-19 Pandemic in King County, WA

Technical Appendix

January 1, 2017 – December 31, 2022

We conducted an analysis of deaths among residents of King County spanning the years 2017 to 2022, utilizing death certificate data sourced from the Washington State Department of Health Center for Health Statistics. We compared deaths in the years 2020-2022 with those that occurred in 2017-2019. Notably, we examined causes of death that might have been indirectly influenced by COVID-19, conducting all analyses irrespective of the COVID-19 status of the decedent.

Given the significant variability in death rates across causes and demographic subpopulations, interpreting changes in death rates can be challenging. To facilitate interpretation, we used rate ratios to compare death rates in 2020-2022 with those in 2017-2019. Understanding these ratios is straightforward: a ratio below one indicates a decreased death rate in 2020-2022, a ratio above one signifies an increased death rate, and a ratio of one denotes a stable death rate. Additionally, the proportion above or below one can be interpreted as a percentage; for instance, a ratio of 0.90 reflects a 10% decrease in death rates, while a ratio of 1.15 indicates a 15% increase. To complement these ratios, we considered death rate differences to assess changes on an absolute scale. Due to widespread concern about changes in life expectancy, life expectancy estimates and differences were also calculated.

Cause of Death Definitions

We received final death data¹ for 2017-2022 from the Washington State Department of Health Center for Health Statistics and identified the cause of death using the International Classification of Diseases, Tenth Revision (ICD-10) underlying cause of death codes. We assessed the leading causes of death (cancer, heart disease, unintentional injury, Alzheimer's disease, and cerebrovascular disease) as well as causes hypothesized to be impacted by the pandemic (drug overdose, diabetes mellitus, suicide, firearm, traffic, homicide, and drowning).

Injury related deaths (drowning, firearm, motor vehicle traffic, homicide, suicide, unintentional injury) were defined using the CDC ICD-10 injury matrix.² Injury intents and mechanisms are not mutually exclusive, i.e., suicide (an intent) includes firearms (a mechanism). Alzheimer's disease, cerebrovascular disease (stroke), and diabetes mellitus deaths were defined using the CDC's List of 113 Selected Causes

¹ <https://www.cdc.gov/surveillance/blogs-stories/understanding-death-data.html>, last accessed 12/07/2023

² https://www.cdc.gov/nchs/data/ice/icd10_transcode.pdf, last accessed 12/07/2023

of Death.³ Cancer (C00–C97), heart disease (I00–I09, I11, I13, I20–I51), and drug overdose (X40–X44, X60–X64, X85, Y10–Y14) also follow CDC standards, with ICD-10 codes provided here for convenience.⁴

Demographics

This report is limited to residents of King County, irrespective of the location of their death. By extension, residents of other counties who died in King County are excluded.

A physician, coroner, or medical examiner certifies the cause of death on a death certificate, while a funeral director, in consultation with the legal next of kin, records demographic information. If the legal next of kin is unavailable or cannot be located, the funeral director may categorize the decedent based on their own observations. Consequently, there is no guarantee that a person's preferred gender, or racial or ethnic identity, will be accurately reflected in the death records. As a result, the gender designation (female or male) on a death certificate typically corresponds to the sex assigned at birth. Moreover, racial and ethnic classifications may be subject to differential miscategorization,⁵ especially when compared to reference populations based on self-reported identity.

In this analysis, Hispanic is treated as a mutually exclusive race rather than an ethnicity, meaning individuals in the data are categorized as either Hispanic or belonging to another race. Multi-racial was excluded as a category due to a high degree of misclassification. Throughout this brief, Native Hawaiian/Pacific Islander is abbreviated as NHPI and American Indian/Alaska Native is abbreviated as AIAN.

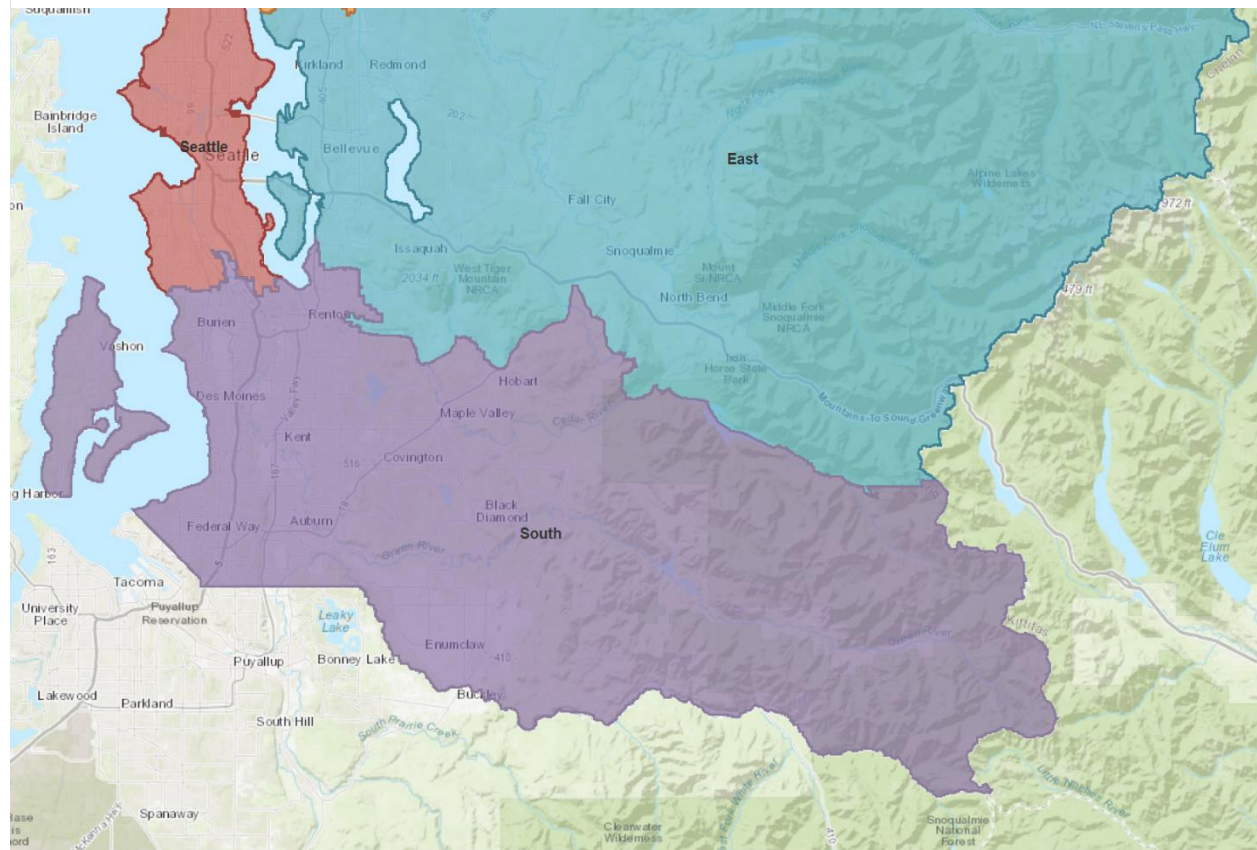
To balance granularity and simplicity in the presentation of estimates, King County has been divided into four regions: Seattle proper, East King County, North King County, and South King County (Figure 1). The East Region includes Bear Creek, Bellevue, Carnation, Duvall, Issaquah, Kirkland, Medina, Mercer Island, Newcastle, North Bend, Redmond, Sammamish, Skykomish, and Snoqualmie. The North Region includes the areas of Bothell, Cottage Lake, Kenmore, Lake Forest Park, Shoreline, and Woodinville. The South Region contains Algona, Auburn, Black Diamond, Burien, Covington, Des Moines, Enumclaw, Fairwood, Federal Way, Hobart, Kent, Lakeland, Maple Valley, Milton, Normandy Park, Pacific, Renton, Tukwila, SeaTac, Skyway, White Center, and Vashon Island.

³ <https://www.cdc.gov/nchs/data/dvs/Part9InstructionManual2020-508.pdf>, Table B, last accessed 12/07/2023

⁴ <https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-08-508.pdf>, Tables C & 12, last accessed 12/07/2023

⁵ https://www.cdc.gov/nchs/data/series/sr_02/sr02_172.pdf, last accessed 12/07/2023

Figure 1. King County Regions



Calculation of Age-adjusted Death Rates

Age-adjustment is a statistical technique for standardizing the age distribution across different populations in order to facilitate comparison between groups. For example, in 2022 almost 88% of Hispanics in King County were under 50 years old, whereas less than 60% of whites were under 50 years old. Since older persons are at greater risk of death, calculating standardized rates across groups allows us to more accurately assess if one group is at higher risk for death for reasons beyond the differences in age. This technique also allows for more accurate comparisons when age distributions of groups have changed over time. All estimates have been age standardized to the 2000 U.S. standard population using 11 age groups.⁶ Exact confidence intervals were calculated following the Fay and Feuer method.⁷ Population denominators are from the Washington State Population Interim Estimates (PIE).⁸ All rates are per 100,000 residents. Death rates are limited to those one year of age and older.

Calculation of Rate Ratios and Differences

We calculated death rate ratios and differences through a process involving 10,000 random draws from the distribution of values represented by age-standardized rates and their corresponding standard

⁶ <https://www.cdc.gov/nchs/data/statnt/statnt20.pdf>, Table 2, Distribution #1.

⁷ Fay MP, Feuer EJ. Confidence intervals for directly standardized rates: a method based on the gamma distribution. *Stat Med.* 1997 Apr 15;16(7):791-801.

⁸ Washington State Population Interim Estimates (PIE), March 2022.

errors for both pre-pandemic (2017-2019) and pandemic (2020-2022) periods. For each draw pair, we computed the ratio (pandemic / pre-pandemic) or difference (pandemic – pre-pandemic). The mean of these 10,000 ratios or differences served as the point estimate, while the 95% confidence interval was established by identifying the values at the 2.5% and 97.5% percentiles of all estimates.

Calculation of Life Expectancy

We calculated life expectancy at birth following standard methods described by Chang.⁹ The single deviation was use of the Silcocks approximation to calculate the variance of the oldest age group.¹⁰ Differences in life expectancy and their corresponding 95% confidence interval were calculated using 10,000 draws as described for calculation of rate differences above.

Calculation of Leading Causes of Death

The leading causes of death categories are aggregations of the standard CDC 113 Selected Causes of Death. Table 1 displays how we combined these causes to identify the top 10 leading causes of death in both 2017-2019 and 2020-2022. Note that the leading causes of death are ranked based on the death count, not age adjusted rates.

Table 1. Crosswalk between the Leading Causes of Death and CDC 113 Selected Causes of Death

Leading Cause of Death	CDC 113 Select Causes of Death
Cancer	Malignant neoplasms of lip, oral cavity and pharynx
Cancer	Malignant neoplasm of esophagus
Cancer	Malignant neoplasm of stomach
Cancer	Malignant neoplasms of colon, rectum and anus
Cancer	Malignant neoplasms of liver and intrahepatic bile ducts
Cancer	Malignant neoplasm of pancreas
Cancer	Malignant neoplasm of larynx
Cancer	Malignant neoplasms of trachea, bronchus and lung
Cancer	Malignant melanoma of skin
Cancer	Malignant neoplasm of breast
Cancer	Malignant neoplasm of cervix uteri
Cancer	Malignant neoplasms of corpus uteri and uterus, part unspecified
Cancer	Malignant neoplasm of ovary
Cancer	Malignant neoplasm of prostate
Cancer	Malignant neoplasms of kidney and renal pelvis
Cancer	Malignant neoplasm of bladder
Cancer	Malignant neoplasms of meninges, brain and other parts of central nervous system
Cancer	Hodgkin's disease

⁹ Chiang, Chin Long & World Health Organization. (1979). Life table and mortality analysis / Chin Long Chiang. World Health Organization. <https://apps.who.int/iris/handle/10665/62916>

¹⁰ Silcocks PB, Jenner DA, Reza R. Life expectancy as a summary of mortality in a population: Statistical considerations and suitability for use by health authorities. J Epidemiol Community Health 55(1):38–43. 2001

Leading Cause of Death	CDC 113 Select Causes of Death
Cancer	Non-Hodgkin's lymphoma
Cancer	Leukemia
Cancer	Multiple myeloma and immunoproliferative neoplasms
Cancer	Other and unspecified malignant neoplasms of lymphoid, hematopoietic and related tissue
Cancer	All other and unspecified malignant neoplasms
Heart disease	Acute rheumatic fever and chronic rheumatic heart diseases
Heart disease	Hypertensive heart disease
Heart disease	Hypertensive heart and renal disease
Heart disease	Acute myocardial infarction
Heart disease	Other acute ischemic heart diseases
Heart disease	Atherosclerotic cardiovascular disease, so described
Heart disease	All other forms of chronic ischemic heart disease
Heart disease	Acute and subacute endocarditis
Heart disease	Diseases of pericardium and acute myocarditis
Heart disease	Heart failure
Heart disease	All other forms of heart disease
Alzheimer's disease	Alzheimer's disease
Unintentional injuries	Motor vehicle crash
Unintentional injuries	Unintentional injury: Other land transport
Unintentional injuries	Unintentional injury: Water, air and space, and other transport
Unintentional injuries	Falls
Unintentional injuries	Accidental discharge of firearms
Unintentional injuries	Accidental drowning and submersion
Unintentional injuries	Accidental exposure to smoke, fire and flames
Unintentional injuries	Accidental poisoning and exposure to noxious substances
Unintentional injuries	Other and unspecified nontransport accidents and their sequelae
Stroke	Cerebrovascular diseases
Chronic lower resp. disease	Bronchitis, chronic and unspecified
Chronic lower resp. disease	Emphysema
Chronic lower resp. disease	Asthma
Chronic lower resp. disease	Other chronic lower respiratory diseases
Diabetes mellitus	Diabetes mellitus
Suicide	Intentional self-harm (suicide) by discharge of firearms
Suicide	Intentional self-harm (suicide) by other and unspecified means and their sequelae
Chronic liver disease	Alcoholic liver disease
Chronic liver disease	Other chronic liver disease and cirrhosis
Influenza and pneumonia	Influenza
Influenza and pneumonia	Pneumonia
COVID-19	COVID-19