

Summary Report on Deaths Associated with COVID-19

September 1st, 2020

Public Health—Seattle & King County (PHSKC) conducts investigations to help understand the circumstances and burden of deaths attributable to COVID-19. To conduct these analyses, PHSKC linked death certificate data (demographic information, causes of death, and death location), electronic lab reporting data (demographic data for all individuals tested for COVID-19 and their test results), and King County Medical Examiner’s Office (KCMEO) data (post-mortem COVID test results and designation of cause of death for decedents with sudden, unexpected, or unnatural deaths). Data were linked based on the decedents name, date of birth, and zip code.

Death counts should be considered preliminary and may change as death certificate or case investigations data are updated. Certification is typically reported within 10 days, but in rare circumstances may take up to one year. *This report will be updated monthly.*

King County COVID-19 Deaths – Key Findings

How does King County define which deaths are related to COVID-19?

PHSKC and Washington State Department of Health classified COVID-19 deaths into four categories:

- **Confirmed:** the deceased person tested positive and had a death certificate noting infection with the virus contributed to death
- **Suspected:** the deceased person tested positive for COVID-19, died of a natural disease, and did not have COVID-19 listed on their death certificate
- **Pending:** awaiting death certificates or deaths where cause of death is missing but do have confirmatory testing for COVID-19
- **Probable:** COVID-19 was listed on the death certificate, but the deceased person did not have a record of confirmatory testing

Deaths where the decedent died of non-natural causes, such as traffic accidents, overdose, homicide, or suicide, are excluded for COVID-19 death reporting, even if the decedent had a positive confirmatory test. Unless otherwise specified, the deaths due to COVID-19 in this report refer to confirmed and suspected COVID-19 deaths. These definitions may change once national case classifications are finalized.

How many King County residents have died due to COVID-19?

Refer to PHSKC's [COVID-19 Outbreak Summary](#), where the death count and trend is updated daily.

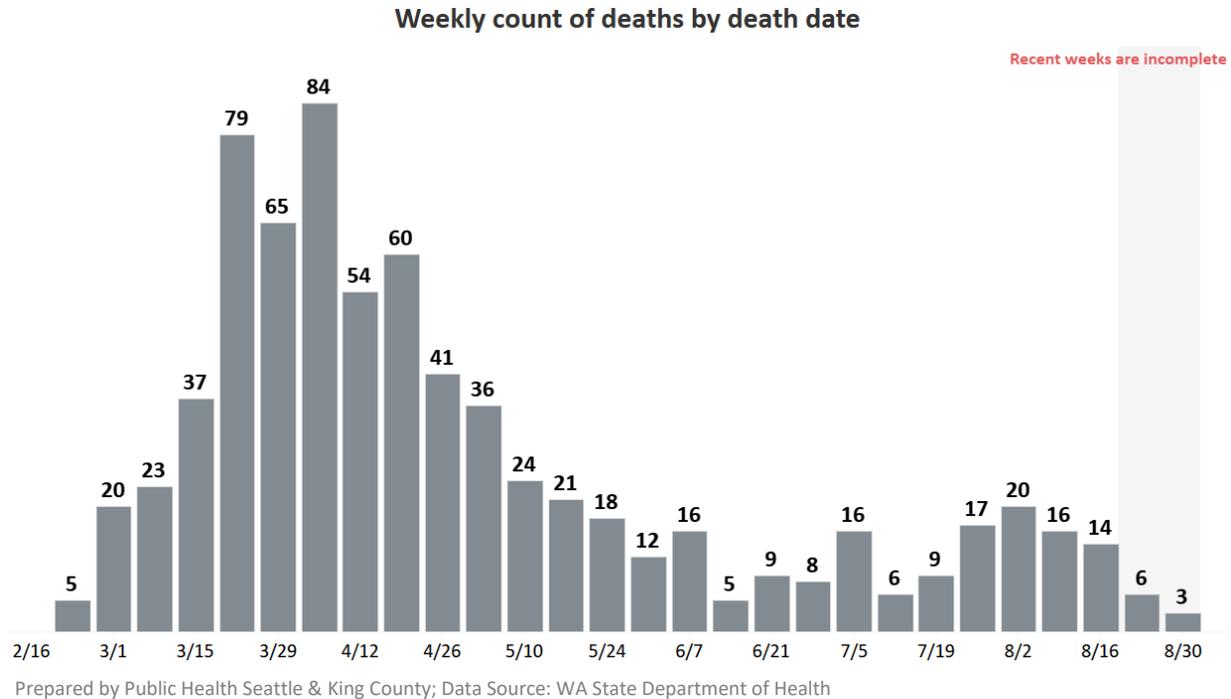
As of September 1, there were 724 deaths associated with COVID-19:

- 94% (680) are confirmed
- 5% (37) are suspected
- 1% (7) are pending

An additional 17 deaths are probable.

How have the number of deaths changed over time?

- The first recognized COVID-19 related death occurred in late February 2020.
- COVID-19 deaths peaked in late March and early April, with a weekly high of 84 deaths the week beginning April 5.
- The weekly count of COVID-19 related deaths decreased steadily between mid-April and mid-June.
- Since mid-June, the count of COVID-19 deaths has ranged between 5 and 20 per week, with increasing counts in July and August (to-date) compared with June.
- Refer to PHSKC's [COVID-19 Outbreak Summary](#), where the death count and trend is updated daily.



Which groups experience the highest burden of COVID-19 deaths?

- The greatest burden of COVID-19 deaths is among those above 60 years old. The early outbreaks of COVID-19 in long-term care facilities led to many deaths among elderly residents, which decreased markedly in April and May in response to effective COVID-19 prevention measures. Through September 1, nearly 54% of those who died from COVID-19 related illness were 80+ years old and more than 90% were 60+ years old. The median age for COVID-19 related deaths has remained around 81 years old since the beginning of the outbreak.
- Overall, Whites account for a disproportionate share of COVID-19 deaths, representing 68% of all deaths relative to 59% of the King County population.
- Although most COVID-19 deaths are among Whites, the age-adjusted rate of death is highest among Native Hawaiian/Pacific Islanders (NHPI) and Hispanics. Among those under 60 years old, Hispanics comprise less than 12% of the population but accounted for 42% of COVID-19 related deaths.
- Adjusted for age¹, the rate of death due to COVID-19 among NHPI (121 per 100,000 residents) and Hispanic/Latinx (84 per 100,000 residents) residents is higher compared to White residents (28 per 100,000 residents). However, residents of skilled nursing and assisted living facilities contributed to a large number of COVID-19 deaths, and the race/ethnicity of residents of these facilities is different than that of the population at large. These disparities in death rates by race/ethnicity widened after excluding residents of skilled nursing and assisted living facilities from the analysis (96 per 100,000 among NHPI; 60 per 100,000 among Hispanic/Latinx, and 10 per 100,000 among Whites).
- The rate of death due to COVID-19 among American Indian / Alaskan Native (AI/AN), Asian and Black county residents did not differ significantly from the rate among Whites. However, racial misclassification, small populations, and missing data may affect the interpretation of these findings, especially regarding AI/AN.
- COVID-19 deaths are more common among males than females (52% vs. 48%, respectively).
- Refer to the Demographics tab of PHSKC's [Daily Outbreak Summary](#) for up-to-date demographic breakdown of death counts and rates by age group, race, and sex at birth.
- Refer to PHSKC's [COVID-19 Race and Ethnicity data dashboard](#) for additional information about deaths by race/ethnicity.

¹ See **Age-adjustment** in the Technical Notes

What are the leading contributing causes of death among persons with a COVID-19 associated death?

- Through August 22nd, respiratory illness was a contributing cause for 73% of COVID-19 related deaths; 49% of all COVID-19 related deaths had pneumonia and 13% had acute respiratory distress syndrome.
- Through August 22nd, cardiovascular disease (CVD) (13%) and sepsis (11%) were also leading contributing causes of death among persons who died of COVID-19.
- Through September 1st, 85% of COVID-19 decedents had a symptomatic illness reported preceding death; fever, shortness of breath, and cough were the most commonly identified symptoms.
- Through September 1st, more than eight out of ten COVID-19 decedents had underlying medical conditions such as heart disease, diabetes, chronic kidney disease, chronic lung disease, or immunosuppression.

How many King County “excess deaths” have there been since the start of 2020?

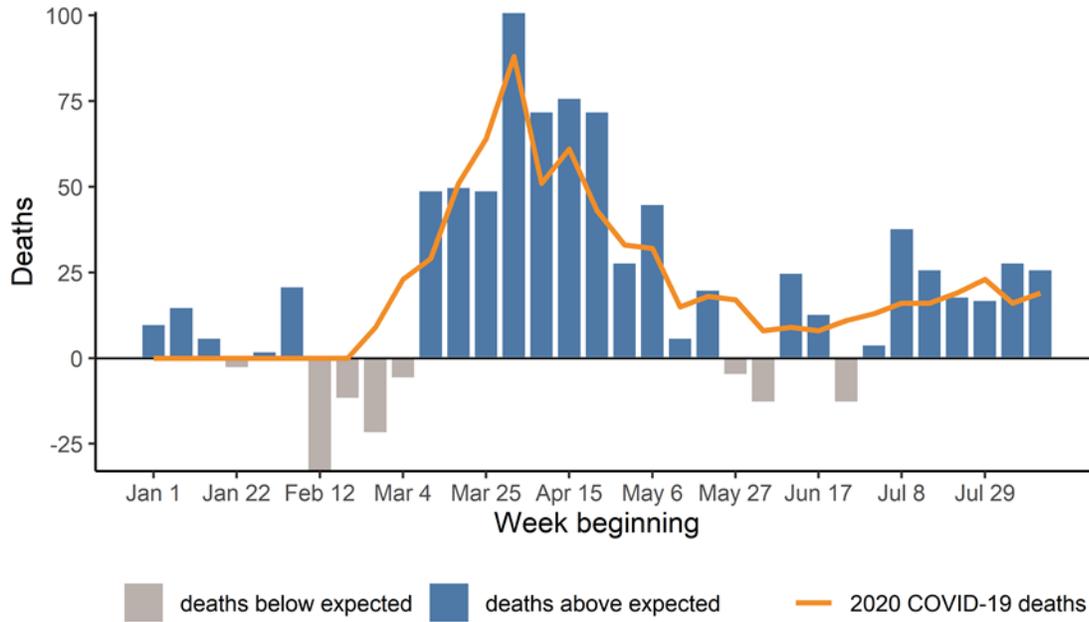
- Excess deaths² are an estimate of the pandemic’s toll on overall mortality. This method estimates weekly deaths in 2020 that are beyond what the county would expect using 2015-2019 as a reference.
- Excess deaths are an alternative way of estimating COVID-19’s death burden that we can use in addition to counting deaths among decedents who tested positive for COVID-19. For example, some decedents may not have been tested for COVID-19 early in the outbreak or before it was recognized locally. The excess deaths estimate includes deaths regardless of testing for COVID-19 or mentions of COVID-19 in the death certificate.
- From January 1 to August 18, PHSKC estimates there have been 817 excess deaths (compared to 2015-2019 levels). Excess deaths accounted for 9% of total King County deaths (9,145) during this period ([Supplemental Table 1](#)).
- During the same time period, the official PHSKC count includes 692 COVID-19 deaths.
- Because the number of excess deaths varies from year to year, we also estimated statistically significant excess deaths above and beyond what would be expected due to typical yearly variation in weekly deaths.
- There were 264 statistically significant excess deaths. This accounts for 3% of King County deaths during this period.
- Some excess deaths can be attributed to acute respiratory distress syndrome (a specific cause of death designation), but our analysis did not find increases for any other assessed cause of death, including cardiovascular and pneumonia deaths. In an analysis that removed all known (diagnosed) COVID-19 related deaths in the pandemic period, there were 42 other acute respiratory distress syndrome deaths compared to an average of 27 in 2017-2019. This suggests that there might have

² See **Excess Deaths Methodology** in the Technical Notes

been unrecognized COVID-19 infections that contributed to excess acute respiratory distress syndrome deaths.

- Based on this analysis, there do not appear to be large numbers of potential COVID-19 deaths that are unrecognized in the official death counts.

Observed 2020 Deaths Above or Below Expected Deaths



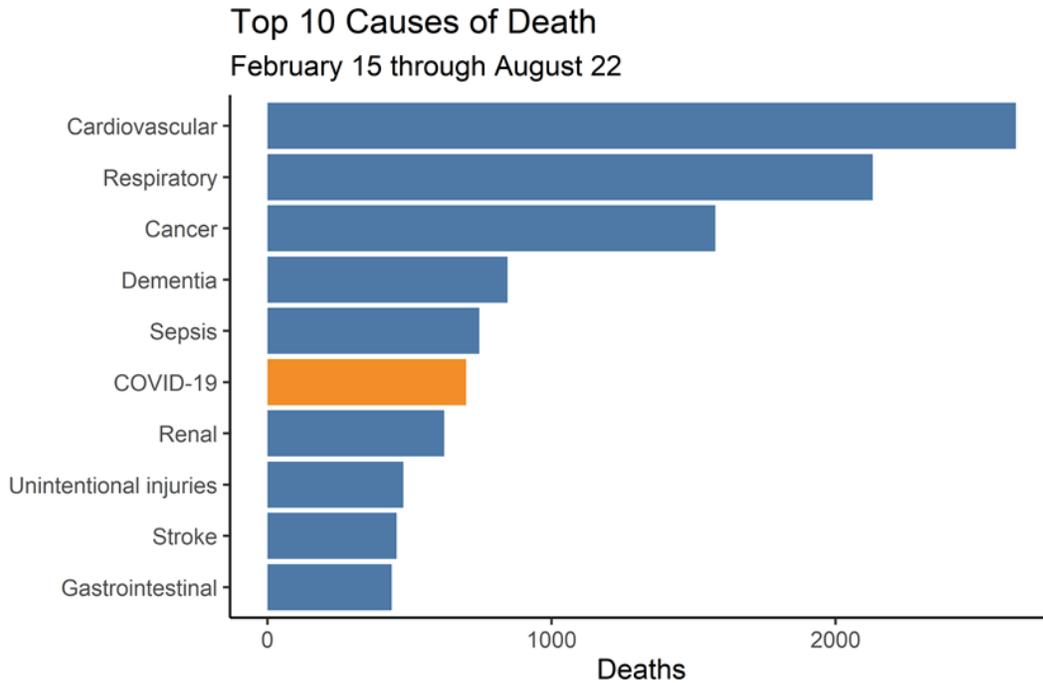
Prepared by Public Health Seattle & King County; Data Source: WA State Department of Health

Are COVID-19 associated deaths early in the epidemic undercounted due to lack of testing?

- We compared death rates during the three months prior to the outbreak (November 1, 2019 through February 15, 2020) to the same period in 2016-2019. We found no evidence for increased rates of respiratory death, cardiovascular death, or death for all causes combined during this time.
- Although there were some weeks with excess deaths in January and February 2020, there was no increase in deaths due to respiratory or cardiovascular causes in the three weeks leading up to the first identified COVID-19 case in King County in late February. This suggests that there was not an unrecognized increase in deaths due to COVID-19 prior to the first identified death. The excess deaths identified at the start of the year are likely attributable to causes unrelated to COVID-19.

How does COVID-19 compare to other causes of death since the start of the pandemic?

- Between February 15 and August 22, COVID-19 ranked 6th among 34 non-mutually exclusive causes of death⁴.
- Weekly COVID-19 related deaths ranked as the 3rd most common cause of death at the peak level in March and early April, but COVID-19 has since dropped to the 8th most common cause of death during the week of August 12 through August 18.



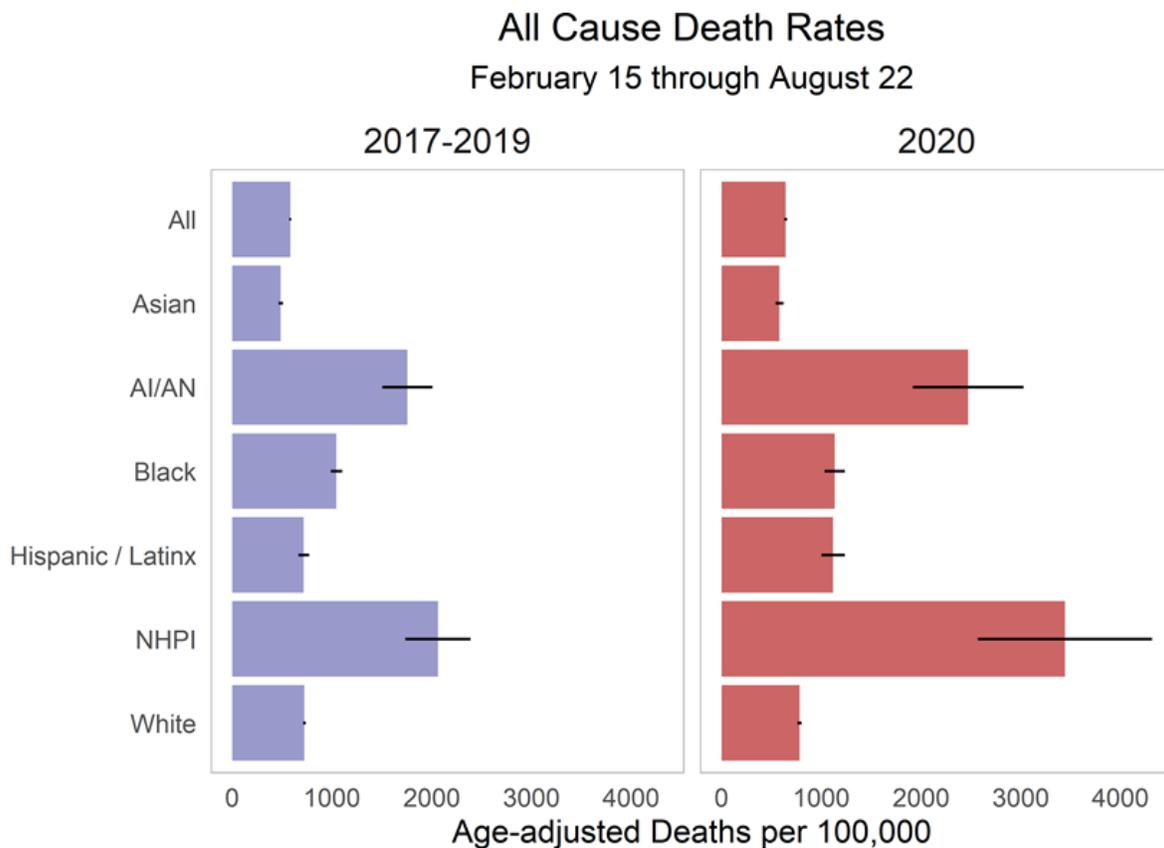
Prepared by Public Health Seattle & King County; Data Source: WA State Department of Health

Are there notable disparities in 2020 death rates for all causes compared to previous years by race and ethnicity?

While excess deaths provide a measure of the degree to which the pandemic impacted overall mortality, comparing death rates over time helps us understand severity of disease. In addition, comparing demographic groups helps identify at-risk populations. As a supplement to the excess deaths analysis described above, we compared age-adjusted death rates from February 15 through August 22 in 2020 relative to 2017-2019, within and across each racial/ethnic group. This analysis combined COVID and non-COVID related deaths.

Overall, the **rate of death for all causes combined** was 10% higher in 2020 relative to 2017-2019 ([Supplementary Table 2](#)).

- The **death rate for all causes combined** increased in 2020 among NHPI (67%), Hispanics/Latinx (56%), AI/AN (41%), Asians (19%), and Whites (8%) relative to 2017-2019.
- For both time periods, the **death rate for all causes combined** among AI/AN, Blacks, and NHPI was higher relative to Whites, and rates for Asians were lower relative to Whites.
- The **death rate for all causes combined** among Hispanics/Latinx was not significantly different relative to Whites in 2017-2019 but was significantly higher in 2020 relative to Whites.



The overall **respiratory death rate** was 26% higher in 2020 relative to 2017-2019 ([Supplementary Table 4](#)).

- **Respiratory death rates** increased in 2020 among NHPI (150%), Hispanics/Latinx (109%), Asians (53%), and Whites (21%) relative to 2017-2019.
- For both time periods, **rates for respiratory deaths** among AI/AN, Blacks, and NHPI were higher relative to Whites, and rates for Asians were lower relative to Whites.
- The **respiratory death rate** among Hispanics/Latinx was not significantly different relative to Whites in 2017-2019 but was significantly higher in 2020 relative to Whites.

The overall **cardiovascular death rate** did not significantly change in 2020 relative to 2017-2019 ([Supplementary Table 6](#)).

- **Cardiovascular disease death rates** increased in 2020 among NHPI (121%) and AI/AN (65%) relative to 2017-2019.
- For both time periods, **rates for cardiovascular disease deaths** among AI/AN, Blacks, and NHPI were higher relative to Whites, rates for Asians were lower relative to Whites, and rates for Hispanics/Latinx did were not significantly different relative to Whites.

Together, these finding suggest that COVID-19 widened existing disparities in death rates that were present prior to the pandemic.

What is the relationship between location of death and COVID-19 positivity?

Most deaths from all causes occurred in residences and hospitals, but most COVID-19 deaths occurred in hospitals and long-term care facilities.

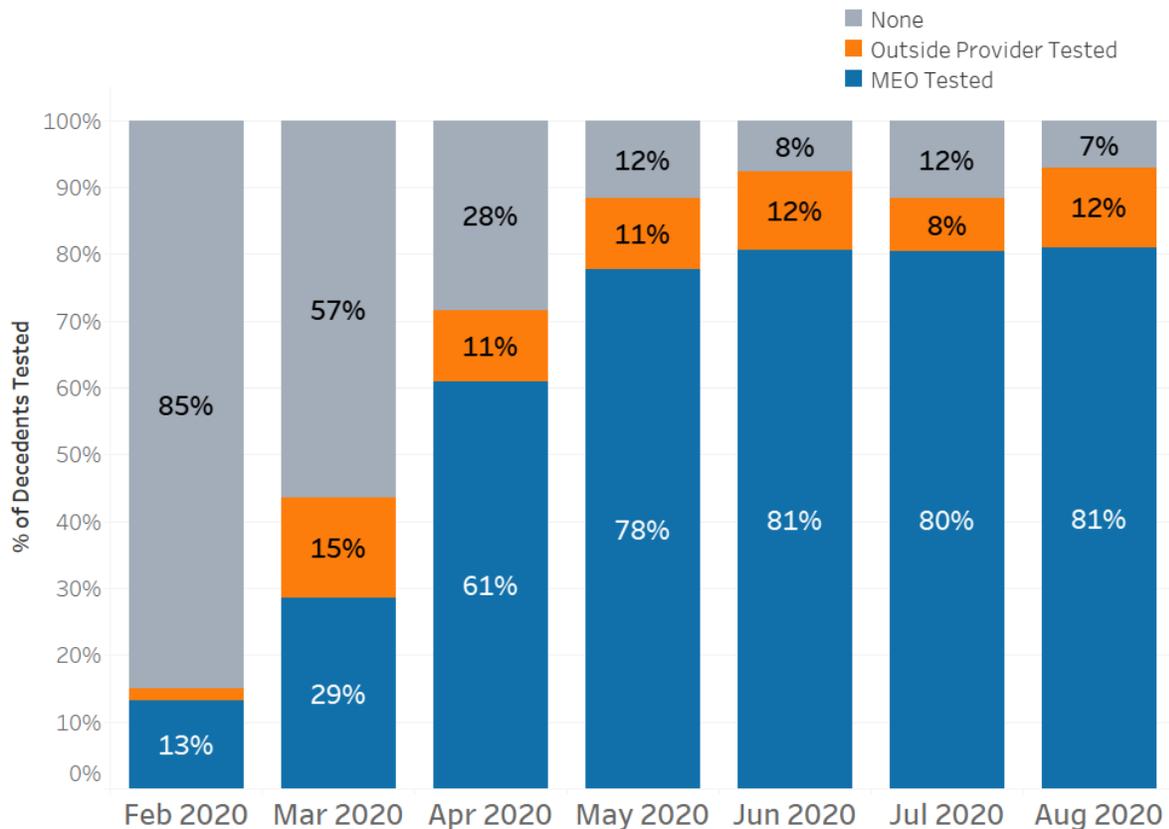
- Between February 15 through August 22, 2020, 39% (2,867) of King County deaths occurred in residences, 33% (2,465) occurred in hospitals, and 18% (1,312) occurred in long-term care facilities. These proportions are similar to those in recent years (2017-2019).
- During the same time window, 56% (391) of COVID+ deaths occurred in hospitals, 27% (188) of COVID+ deaths occurred in long-term care facilities, 10% (67) of COVID+ deaths occurred in residences, 3% (21) of COVID+ deaths occurred in hospices, and 5% (32) of COVID+ deaths occurred in other locations. These proportions have remained relatively stable over time.
- Among decedents who were tested for COVID-19, deaths occurring in hospitals were more likely to have a positive result (27%) compared to deaths occurring in residences (6%).
- The proportion tested for COVID-19 among hospital deaths and residence deaths without recent medical care did not vary significantly by race/ethnicity.

Is King County attempting to perform COVID-19 tests for those who died without testing?

The King County Medical Examiner’s Office is performing COVID-19 testing for most of the decedents in its jurisdiction.

- From February 15 through September 1, the King County Medical Examiner’s Office (KCMEO) assumed jurisdiction of 2,193 decedents, tested 65% (1,420) of these decedents, and found 7% (95) of those tested were positive for COVID-19.
- There were similarities and differences when comparing those who KCMEO found to be COVID positive versus all COVID deaths: they were less likely to be White (61% vs. 68%) and less likely to be over 60 years old (74% vs. 90%). They were slightly more likely to be males (54% vs. 52%).
- KCMEO has increased its capacity to test decedents post-mortem throughout the outbreak and is now testing approximately 80% of decedents for COVID-19.
- Less than half (45%) of decedents under KCMEO's jurisdiction receive only a death certificate review and do not come to the office for a post-mortem exam. Of these decedents, 56% were tested for COVID through field investigation teams due to clinical indications or congregate settings of concern. An additional 20% of these decedents were tested by an outside provider, and the remaining 24% were not tested due to no clinical or epidemiologic indications.

Percentage of decedents in KCMEO jurisdiction tested for COVID-19, by month of death



Prepared by Public Health Seattle & King County; Data Sources: King County Medical Examiner's Office (KCMEO) & WA State Department of Health

Appendices

Supplementary Table 1. Summary of Excess Deaths between January 1 and August 18, 2020

Week beginning	Observed	Expected	Excess	COVID+	Percent excess
Jan 1	288	278	10	0	3.6%
Jan 8	294	279	15	0	5.3%
Jan 15	288	282	6	0	2.2%
Jan 22	271	274	0	0	-
Jan 29	281	279	2	0	0.8%
Feb 5	299	278	21	0	7.6%
Feb 12	241	274	0	0	-
Feb 19	261	273	0	0	-
Feb 26	252	274	0	9	-
Mar 4	262	268	0	23	-
Mar 11	315	266	49	29	18.6%
Mar 18	319	269	50	51	18.6%
Mar 25	316	267	49	64	18.3%
Apr 1	360	259	101	88	38.8%
Apr 8	328	256	72	51	28.3%
Apr 15	330	254	76	61	29.8%
Apr 22	323	251	72	43	28.5%
Apr 29	278	250	28	33	11.3%
May 6	290	245	45	32	18.3%
May 13	251	245	6	15	2.3%
May 20	263	243	20	18	8.2%
May 27	238	243	0	17	-
Jun 3	228	241	0	8	-
Jun 10	270	245	25	9	10.2%
Jun 17	255	242	13	8	5.5%
Jun 24	231	244	0	11	-
Jul 1	245	241	4	13	1.5%
Jul 8	278	240	38	16	15.7%
Jul 15	264	238	26	16	11%
Jul 22	258	240	18	19	7.3%
Jul 29	253	236	17	23	7%
Aug 5	259	231	28	16	12.2%
Aug 12	256	230	26	19	11.4%
Total	9,145	8,435	817	692	8.9%

**Excess deaths are the Observed minus the Expected. COVID+ deaths are included in the observed number of deaths.*

Supplementary Table 2. Age-adjusted all-cause death rates and ratios between February 15 and August 22

Strata	Ave Deaths 2017-2019	Deaths 2020	COVID Tested	COVID+	Rate (95% CI) 2017-2019	Rate (95% CI) 2020	Ratio (95% CI)	Significant
All	6,664	7,441	3,380	699	582.86 (574.61 — 591.11)	643.23 (628.5 — 657.97)	1.10 (1.07—1.13)	Yes
Asian	635	783	379	103	487.14 (465.12 — 509.15)	581.18 (540.39 — 621.97)	1.19 (1.10—1.30)	Yes
AI/AN	63	76	34	4	1756.12 (1505.45 — 2006.78)	2471.87 (1915.97 — 3027.77)	1.41 (1.08—1.84)	Yes
Black	437	485	234	43	1046.01 (989.06 — 1102.95)	1136.48 (1035.13 — 1237.82)	1.09 (0.98—1.21)	No
Hispanic	229	353	171	61	717.17 (662.53 — 771.8)	1118.98 (1001.36 — 1236.61)	1.56 (1.37—1.77)	Yes
NHPI	51	60	28	7	2062.65 (1736.13 — 2389.17)	3444.02 (2571.88 — 4316.16)	1.67 (1.24—2.25)	Yes
White	5,150	5,574	2,487	474	724.32 (712.77 — 735.88)	782.08 (761.47 — 802.69)	1.08 (1.05—1.11)	Yes
Female	3,257	3,590	1,579	336	516.94 (506.63 — 527.25)	566.39 (547.83 — 584.95)	1.10 (1.05—1.14)	Yes
Male	3,407	3,799	1,750	348	746.18 (731.35 — 761.01)	822.09 (795.71 — 848.47)	1.10 (1.06—1.14)	Yes

* *Significant = “Yes” indicates statistically significant increase in the rate of death in 2020 relative to 2017-2019.*

Supplementary Table 3. Age stratified all-cause death rates and ratios between February 15 and August 22

Strata	Ave Deaths 2017-2019	Deaths 2020	COVID Tested	COVID+	Rate (95% CI) 2017-2019	Rate (95% CI) 2020	Ratio (95% CI)	Significant
0-18	80	92	26	1	16.73 (14.62 — 18.84)	18.98 (15.1 — 22.85)	1.13 (0.89 — 1.44)	No
19-50	532	658	317	29	49.67 (47.23 — 52.11)	60.06 (55.48 — 64.65)	1.21 (1.10 — 1.32)	Yes
51-64	947	1,042	517	85	260.22 (250.65 — 269.79)	286.44 (269.05 — 303.83)	1.10 (1.03 — 1.18)	Yes
65-84	2,579	2,929	1,389	295	1068.06 (1044.26 — 1091.86)	1170.98 (1128.57 — 1213.39)	1.10 (1.05 — 1.14)	Yes
85+	2,525	2,720	1,131	289	7703.42 (7529.95 — 7876.88)	8472.04 (8153.66 — 8790.43)	1.10 (1.05 — 1.15)	Yes

* *Significant = “Yes” indicates statistically significant increase in the rate of death in 2020 relative to 2017-2019.*

Supplementary Table 4. Age-adjusted respiratory death rates and ratios between February 15 and August 22

Strata	Ave Deaths 2017-2019	Deaths 2020	COVID Tested	COVID+	Rate (95% CI) 2017-2019	Rate (95% CI) 2020	Ratio (95% CI)	Significant
All	1,676	2,131	1,231	512	153.48 (149.18 — 157.77)	192.75 (184.52 — 200.98)	1.26 (1.19 — 1.32)	Yes
Asian	157	252	162	82	128.83 (117.14 — 140.53)	197.73 (173.27 — 222.18)	1.53 (1.32 — 1.79)	Yes
AI/AN	16	17	9	2	491.6 (353.81 — 629.38)	586.87 (307.84 — 865.9)	1.19 (0.69 — 2.07)	No
Black	110	125	74	32	285.41 (254.44 — 316.37)	315.87 (260.42 — 371.32)	1.11 (0.90 — 1.36)	No
Hispanic	50	104	63	46	190.99 (159.95 — 222.03)	399.97 (322.63 — 477.31)	2.09 (1.63 — 2.69)	Yes
NHPI	11	20	10	6	526.63 (349.33 — 703.93)	1318.86 (740.36 — 1897.36)	2.50 (1.44 — 4.35)	Yes
White	1,308	1,588	899	340	190.96 (184.94 — 196.99)	231.17 (219.77 — 242.58)	1.21 (1.14 — 1.28)	Yes
Female	838	1,028	583	233	137.65 (132.24 — 143.05)	167.33 (157.09 — 177.58)	1.22 (1.13 — 1.31)	Yes
Male	838	1,083	628	269	195.08 (187.32 — 202.83)	248.85 (233.92 — 263.77)	1.28 (1.19 — 1.37)	Yes

* Significant = "Yes" indicates statistically significant increase in the rate of death in 2020 relative to 2017-2019.

Supplementary Table 5. Age stratified respiratory death rates and ratios between February 15 and August 22

Strata	Ave Deaths 2017-2019	Deaths 2020	COVID Tested	COVID+	Rate (95% CI) 2017-2019	Rate (95% CI) 2020	Ratio (95% CI)	Significant
0-18	19	18	3	0	3.89 (2.87 — 4.91)	3.71 (2 — 5.43)	0.96 (0.56 — 1.62)	No
19-50	64	79	47	18	6 (5.16 — 6.85)	7.21 (5.62 — 8.8)	1.20 (0.92 — 1.56)	No
51-64	206	264	148	61	56.51 (52.05 — 60.97)	72.57 (63.82 — 81.33)	1.28 (1.11 — 1.48)	Yes
65-84	728	953	575	230	301.31 (288.67 — 313.95)	381 (356.81 — 405.19)	1.26 (1.17 — 1.36)	Yes
85+	660	817	458	203	2013.3 (1924.62 — 2101.98)	2544.73 (2370.23 — 2719.22)	1.26 (1.17 — 1.37)	Yes

* Significant = "Yes" indicates statistically significant increase in the rate of death in 2020 relative to 2017-2019.

Supplementary Table 6. Age-adjusted cardiovascular death rates and ratios between February 15 and August 22

Strata	Ave Deaths 2017-2019	Deaths 2020	COVID Tested	COVID+	Rate (95% CI) 2017-2019	Rate (95% CI) 2020	Ratio (95% CI)	Significant
All	2,515	2,635	1,091	102	229.61 (224.36 — 234.86)	237.46 (228.35 — 246.57)	1.03 (0.99 — 1.08)	No
Asian	238	266	121	20	195.72 (181.3 — 210.15)	208.76 (183.64 — 233.88)	1.07 (0.93 — 1.23)	No
AI/AN	20	29	11	1	604.99 (451.77 — 758.21)	1001.18 (636.7 — 1365.66)	1.65 (1.06 — 2.58)	Yes
Black	184	201	94	7	478.26 (438.13 — 518.39)	507.28 (437.03 — 577.52)	1.06 (0.90 — 1.25)	No
Hispanic	73	89	34	5	287.94 (249.49 — 326.4)	344.24 (272.46 — 416.03)	1.20 (0.93 — 1.53)	No
NHPI	20	31	13	1	923.7 (687.51 — 1159.88)	2039.44 (1320.79 — 2758.08)	2.21 (1.43 — 3.41)	Yes
White	1,945	1,986	806	67	281.72 (274.43 — 289.02)	286.98 (274.33 — 299.64)	1.02 (0.97 — 1.07)	No
Female	1,201	1,258	518	51	195.28 (188.87 — 201.69)	202.74 (191.52 — 213.96)	1.04 (0.97 — 1.11)	No
Male	1,314	1,367	564	49	307.74 (297.97 — 317.51)	315.4 (298.58 — 332.22)	1.02 (0.96 — 1.09)	No

* Significant = "Yes" indicates statistically significant increase in the rate of death in 2020 relative to 2017-2019.

Supplementary Table 7. Age stratified cardiovascular death rates and ratios between February 15 and August 22

Strata	Ave Deaths 2017-2019	Deaths 2020	COVID Tested	COVID+	Rate (95% CI) 2017-2019	Rate (95% CI) 2020	Ratio (95% CI)	Significant
0-18	14	16	1	0	2.85 (1.98 — 3.72)	3.3 (1.68 — 4.92)	1.16 (0.65 — 2.07)	No
19-50	101	116	57	3	9.39 (8.33 — 10.45)	10.59 (8.66 — 12.52)	1.13 (0.91 — 1.40)	No
51-64	332	344	154	18	91.32 (85.65 — 96.99)	94.56 (84.57 — 104.56)	1.04 (0.92 — 1.17)	No
65-84	970	1,081	496	44	401.66 (387.07 — 416.25)	432.17 (406.41 — 457.93)	1.08 (1.00 — 1.15)	No
85+	1,098	1,078	383	37	3350.42 (3236.02 — 3464.82)	3357.67 (3157.23 — 3558.11)	1.00 (0.94 — 1.07)	No

* Significant = "Yes" indicates statistically significant increase in the rate of death in 2020 relative to 2017-2019.

Technical Notes

Age-adjustment

Age-adjustment is a statistical technique for standardizing the age distribution across different populations in order to facilitate comparison between groups. For example, almost 90% of Hispanics in King County are under 50 years old, whereas less than 65% of Whites are under 50 years old. Since older persons are at much 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.

We modeled death rates using Poisson regression models with the natural log of the population as the offset. Age-adjusted models included age as a natural cubic spline with three degrees of freedom. We then used the R `prediction` package to calculate the average predicted rates across the population distribution of age.

Cause of Death Definitions

Final encoding of death certificate data into ICD-10 codes is a process that can take up to 12 to 18 months. In order to conduct mortality surveillance with minimal delays, 34 causes of death were classified by systematically searching the open text immediate causes of death fields (cause A-D) on the death certificates. The search terms could appear in any of the four cause fields and causes of death were not ascribed a hierarchy and are not mutually exclusive. For example, if a decedent had renal failure, which gave rise to pulmonary edema and cardiac arrest, the individual would be classified as having renal, respiratory, and CVD related death. To avoid introducing temporal biases from using ICD-10 codes with older data and open text for newer data, we applied the search string algorithm to entirety of our dataset.

Below we present the search strings for the top two causes of death. Additional search algorithms are available upon request.

Cardiovascular Disease

- “aneurysm” OR “aorta” OR “aortic” OR “arrhythmi” OR “arteriosclerosis” OR “artery” OR “asystole” OR “atherosclerotic cerebral disease” OR “atrial fiberlation” OR “atrial fibrillation” OR “card” OR “cerebrovascular” OR “chf” OR “congestive heart” OR “coronary” OR “cor pulmonale” OR “deep vein thromb” OR “deep vein thrombosis” OR “deep venous thromb” OR “heart attack” OR “heart block” OR “heart disease” OR “heart failure” OR “hypertension” OR “hypertensive disease” OR “infarct” OR “ischemia” OR “left ventri” OR “mitral regurgitation” OR “peripheral arterial disease” OR “pulmonary embol” OR “pulmonary embolism” OR “pulmonary thromboembol” OR “pulseless electrical activity” OR “recurrent venous thrombosis” OR “resuscitated arrest” OR “stemi” OR “vascular disease” OR “vascular ischemic” OR “venous insufficiency” OR “ventricular fibrillation”
- “atherosclero” NOT “cereb”
- “vascular” NOT (“cereb” OR “dementia” OR “alz” OR “brain” OR “cerbro”)

- “heart” AND “failure”

Respiratory

- “asthma” OR “bronchitis” OR “chronic obstructive” OR “chronic pulmonary disease” OR “chronic pulmonary obstructive disease” OR “copd” OR “diffuse alveolar damage” OR “dyspnea” OR “emphysema” OR “hypox” OR “influenza” OR “obstructive bronchitis” OR “pneumoni” OR “pneumonia” OR “pulmonary arrest” OR “pulmonary failure” OR “pulmonary infection” OR “respir” OR “rsv” OR “syncytial vir” OR “tuberculosis”

Data Sources

The following datasets were used to produce this report.

1. Death certificate data provided by the Washington Department of Health including all information that appears on a decedent’s death certificate including demographic information, causes of death, and death location. Note that racial and ethnic classifications are subject to misclassification. Since self-identification is not possible, classification is often determined by a funeral director.
2. Electronic lab reporting data from the Washington Department of Health providing demographic information on all individuals tested for COVID-19, positive or negative, to enable us to match with the death certificate dataset.
3. King County Medical Examiner data including all deaths under KCMEO jurisdiction and testing performed and results for all decedents.

These data were combined utilizing Link King software based on name, date of birth, and zip code of decedents in all datasets. Racial and ethnic categorization was based solely on death certificates.

Deaths among Adult Family Home Residents

Decedents were classified as adult family home residents if their residence address or death address matched to an address list of DSHS licensed adult family homes in King County.

Excess Deaths Methodology

Excess death analyses assessed whether COVID-19 may have contributed to higher than expected death rates even when death records make no mention of an infection. In other words, this analysis attempted to identify the undercounting of COVID-19 associated mortality. We followed the methodology used by the CDC to calculate excess deaths associated with COVID-19.³ We calculated the weekly difference between the 2020 observed number of deaths and the expected number of deaths based on data from the same time period in the previous five years (2015-2019).

³ https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm, June 10, 2020

Rather than defining the expected number of deaths as the simple average of the historic number of deaths, we used the Farrington algorithm⁴ in the R surveillance package⁵. The Farrington algorithm, which was designed for early outbreak detection, uses an overdispersed Poisson generalized linear model with reweighting to account for past outbreaks. Time (week of the year) was modeled as a spline with 6 knots to account for seasonal variation, the window was set so that there were 2 weeks on either side of the current week, and other settings followed those by Salmon et al 2016. We deviated from the CDC methodology by reporting the number of deaths exceeding the point estimate. In contrast, the CDC reports the number of deaths exceeding those of the predicted upper 95% confidence interval, i.e., statistically significant excess deaths.

The calculation of the total “Percent excess possibly attributable to COVID+” prohibits the carrying over of COVID+ deaths to another week. For example, in a week with 14 excess deaths and 20 COVID+ deaths, only 14 COVID+ deaths would be attributed to the excess deaths. The remaining 6 COVID+ deaths would not be attributed to deaths in the following week(s).

Testing/Place of death

Decedents who died in a residence were classified as recently receiving medical care if they were not referred to the Medical Examiner’s Office because they had received medical care in the last 36 hours and that provider was willing to certify the death. This is often an indicator of decedents who were on home hospice care.

⁴ Farrington, C., Andrews, N., Beale, A., & Catchpole, M. (1996). A Statistical Algorithm for the Early Detection of Outbreaks of Infectious Disease. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, 159(3), 547-563. [doi:10.2307/2983331](https://doi.org/10.2307/2983331)

⁵ Salmon M, Schumacher D, Hohle M (2016). “Monitoring Count Time Series in R: Aberration Detection in Public Health Surveillance.” *Journal of Statistical Software*, 70(10), 1-35. doi: 10.18637/jss.v070.i10.