Additional data

**Excess Mortality Burden of Gastrointestinal, Liver, and Pancreatic Diseases During the COVID-19 Pandemic in the United States, 2020-2022**

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# Additional Table 1. qAIC score of digestive related diseases by knots.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Knot | **GI diseases** | | | | | | | | **Liver and pancreatic diseases** | | | | | | **Sum** |
| GI hemorrhage, NOS | Ulcer | Paralytic ileus and intestine obstruction | Vascular disorder of intestine | *C. difficile* colitis | EC | GC | CRC | ALD | Fibrosis/  cirrhosis | Chronic hepatitis C | Hepatic failure | LIHC | AP |
| 1 | 2297.1 | 1835.1 | 1746.4 | 1676.7 | 2016.8 | 1898.6 | 2054.8 | 1839.7 | 2409.9 | 1940.9 | 2004.0 | 2021.3 | 1874.8 | 1755.9 | 29118.8 |
| 2 | 2069.6 | 1768.8 | 1724.6 | 1657.9 | 1957.7 | 1898.8 | 2062.0 | 1840.4 | 2312.4 | 1848.0 | 1986.3 | 1938.5 | 1875.0 | 1743.4 | 28435.6 |
| 3 | 2019.5 | 1774.8 | 1727.5 | 1664.7 | 1954.7 | 1907.1 | 2070.4 | 1843.9 | 2303.5 | 1852.8 | 1993.4 | 1945.8 | 1882.0 | 1745.3 | 28442.6 |
| 4 | 1948.3 | 1752.4 | 1731.9 | 1664.6 | 1943.4 | 1913.4 | 2078.8 | 1852.8 | 2299.8 | 1850.9 | 1993.8 | 1946.7 | 1880.2 | 1737.5 | 28357.3 |
| 5 | 1912.6 | 1756.5 | 1730.2 | 1669.5 | 1943.3 | 1920.3 | 2087.4 | 1854.6 | 2298.4 | 1849.2 | 1990.6 | 1942.1 | 1884.2 | 1737.1 | 28342.7 |
| 6 | 1853.0 | 1758.1 | 1724.9 | 1668.4 | 1940.2 | 1921.9 | 2092.7 | 1836.6 | 2261.7 | 1833.2 | 1980.7 | 1939.0 | 1880.4 | 1731.5 | 28188.4 |
| 7 | 1849.8 | 1762.5 | 1731.8 | 1677.0 | 1952.1 | 1930.8 | 2092.6 | 1843.5 | 2263.8 | 1842.1 | 1978.3 | 1948.3 | 1887.5 | 1742.8 | 28274.2 |
| 8 | 1849.8 | 1758.1 | 1738.0 | 1680.4 | 1942.5 | 1937.7 | 2100.7 | 1843.8 | 2266.5 | 1839.2 | 1976.1 | 1953.1 | 1892.9 | 1742.5 | 28298.7 |
| 9 | 1846.6 | 1764.0 | 1742.3 | 1684.8 | 1952.8 | 1939.2 | 2103.1 | 1851.6 | 2271.0 | 1836.5 | 1975.4 | 1958.4 | 1897.7 | 1745.7 | 28352.5 |
| 10 | 1853.0 | 1776.0 | 1752.4 | 1692.7 | 1944.9 | 1941.0 | 2108.4 | 1851.2 | 2278.8 | 1835.9 | 1982.7 | 1965.1 | 1903.9 | 1754.7 | 28424.7 |
| 11 | 1852.0 | 1777.1 | 1760.1 | 1700.3 | 1947.3 | 1954.5 | 2115.6 | 1854.5 | 2279.9 | 1841.6 | 1989.1 | 1969.6 | 1911.5 | 1762.2 | 28506.1 |
| 12 | 1854.5 | 1777.9 | 1766.3 | 1705.6 | 1958.2 | 1955.1 | 2117.0 | 1861.4 | 2275.9 | 1847.1 | 1984.5 | 1979.0 | 1918.0 | 1768.8 | 28562.6 |

Abbreviations: qAIC, quasi-akaike information criterion; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; EC, esophageal cancer; GC, gastric cancer; CRC, colorectal cancer; ALD, Alcoholic liver disease; LIHC, liver and intrahepatic bile duct cancer; AP, acute pancreatitis; PC, pancreatic cancer.

# Additional Table 2. The dispersion parameter value of regression models for cause-specific diseases.

|  |  |  |
| --- | --- | --- |
| **Cause of disease a** | **Dispersion** | **P value** |
| **GI disease** |  |  |
| GI hemorrhage, NOS | 17.42 | ＜0.001 |
| Ulcers | 3.45 | ＜0.001 |
| Paralytic ileus and intestine obstruction | 2.93 | ＜0.001 |
| Vascular disorder of intestine | 2.09 | ＜0.001 |
| *C. difficile* colitis | 3.51 | ＜0.001 |
| EC | 1.18 | 0.055 |
| GC | 1.01 | 0.452 |
| CRC | 2.41 | ＜0.001 |
| **Liver and pancreatic diseases** |  |  |
| ALD | 17.23 | ＜0.001 |
| Fibrosis/cirrhosis | 12.82 | ＜0.001 |
| Chronic hepatitis C | 3.35 | ＜0.001 |
| Hepatic failure | 4.38 | ＜0.001 |
| LIHC | 1.65 | ＜0.001 |
| AP | 3.01 | ＜0.001 |
| PC | 2.20 | ＜0.001 |

Abbreviations: GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; EC, esophageal cancer; GC, gastric cancer; CRC, colorectal cancer; ALD, alcoholic liver disease; LIHC, liver and intrahepatic bile duct cancer; AP, acute pancreatitis; PC, pancreatic cancer.

a The contributing causes of death was adopted.

# Additional Table 3. Excess mortality associated with digestive related diseases from March 2020 to February 2021.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Cause of death a** | **Observed deaths, No.** | **Expected deaths**  **No. (95% CI)** | **Excess deaths**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk %**  **(95% CI) d** |  |
| **GI diseases** | | | | | |  |
| GI hemorrhage, NOS | 43771 | 34824 (34402, 35042) | 8947 (8524, 9164) | 27.0 (25.7, 27.6) | 25.7 (24.5, 26.9) |  |
| Ulcers | 8187 | 7088 (6913, 7179) | 1099 (925, 1190) | 3.3 (2.8, 3.6) | 15.5 (13.0, 18.0) |  |
| Paralytic ileus and intestine obstruction | 19248 | 19253 (18944, 19413) | -5 (-315, 155) | 0.0 (-0.9, 0.5) | 0.0 (-1.4, 1.4) |  |
| Vascular disorder of intestine | 15805 | 15926 (15642, 16073) | -121 (-406, 26) | -0.4 (-1.2, 0.1) | -0.8 (-2.3, 0.8) |  |
| *C. difficile* colitis | 7792 | 6614 (6453, 6699) | 1178 (1016, 1262) | 3.5 (3.1, 3.8) | 17.8 (15.2, 20.4) |  |
| EC | 17296 | 17983 (17703, 18128) | -687 (-967, -542) | -2.1 (-2.9, -1.6) | -3.8 (-5.2, -2.4) |  |
| GC | 12321 | 12266 (12049, 12379) | 55 (-162, 168) | 0.2 (-0.5, 0.5) | 0.4 (-1.3, 2.2) |  |
| CRC | 63079 | 61065 (60489, 61360) | 2014 (1439, 2310) | 6.1 (4.3, 7.0) | 3.3 (2.5, 4.1) |  |
| **Liver and pancreatic diseases** | | | | | |  |
| ALD | 40358 | 33115 (32750, 33303) | 7243 (6878, 7431) | 21.8 (20.7, 22.4) | 21.9 (20.7, 23.1) |  |
| Fibrosis/cirrhosis | 52015 | 47332 (46836, 47588) | 4683 (4186, 4938) | 14.1 (12.6, 14.9) | 9.9 (9.0, 10.8) |  |
| Chronic hepatitis C | 14932 | 12835 (12603, 12955) | 2097 (1865, 2217) | 6.3 (5.6, 6.7) | 16.3 (14.5, 18.2) |  |
| Hepatic failure | 30437 | 28329 (27968, 28514) | 2108 (1748, 2294) | 6.4 (5.3, 6.9) | 7.4 (6.2, 8.7) |  |
| LIHC | 31584 | 31400 (31011, 31601) | 184 (-206, 384) | 0.6 (-0.6, 1.2) | 0.6 (-0.5, 1.7) |  |
| AP | 7150 | 5800 (5642, 5882) | 1350 (1193, 1433) | 4.1 (3.6, 4.3) | 23.3 (20.4, 26.1) |  |
| PC | 49434 | 50073 (49555, 50340) | -639 (-1158, -373) | -1.9 (-3.5, -1.1) | -1.3 (-2.1, -0.4) |  |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; EC, esophageal cancer; GC, gastric cancer; CRC, colorectal cancer; ALD, alcohol liver disease; LIHC, liver and intrahepatic cancer; AP, acute pancreatitis; PC, pancreatic cancer.

a The contributing cause of death was adopted.

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

# Additional Table 4. Excess mortality associated with digestive related diseases from March 2021 to February 2022.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Cause of death a** | **Observed deaths, No.** | **Expected deaths No. (95% CI)** | **Excess deaths**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk %**  **(95% CI) d** |  |
| **GI diseases** | - | - | - | - | - |  |
| GI hemorrhage, NOS | 45021 | 35102 (34677, 35320) | 9919 (9495, 10138) | 29.9 (28.6, 30.5) | 28.3 (27.1, 29.4) |  |
| Ulcers | 8585 | 7304 (7126, 7396) | 1281 (1104, 1374) | 3.9 (3.3, 4.1) | 17.5 (15.1, 20.0) |  |
| Paralytic ileus and intestine obstruction | 20601 | 20032 (19716, 20195) | 569 (253, 733) | 1.7 (0.8, 2.2) | 2.8 (1.4, 4.2) |  |
| Vascular disorder of intestine | 16403 | 16585 (16295, 16735) | -182 (-472, -32) | -0.5 (-1.4, -0.1) | -1.1 (-2.6, 0.4) |  |
| *C. difficile* colitis | 8247 | 5667 (5518, 5745) | 2580 (2431, 2658) | 7.8 (7.3, 8.0) | 45.5 (42.4, 48.7) |  |
| EC | 17627 | 18670 (18384, 18817) | -1043 (-1328, -895) | -3.1 (-4.0, -2.7) | -5.6 (-7.0, -4.2) |  |
| GC | 12036 | 12521 (12302, 12635) | -485 (-704, -371) | -1.5 (-2.1, -1.1) | -3.9 (-5.6, -2.1) |  |
| CRC | 63923 | 61558 (60980, 61855) | 2365 (1787, 2662) | 7.1 (5.4, 8.0) | 3.8 (3.0, 4.6) |  |
| **Liver and pancreatic diseases** | - | - | - | - | - |  |
| ALD | 43258 | 34735 (34361, 34928) | 8523 (8149, 8716) | 25.7 (24.6, 26.3) | 24.5 (23.4, 25.7) |  |
| Fibrosis/cirrhosis | 55267 | 49875 (49365, 50137) | 5392 (4883, 5654) | 16.2 (14.7, 17.0) | 10.8 (9.9, 11.7) |  |
| Chronic hepatitis C | 13746 | 11824 (11601, 11939) | 1922 (1699, 2038) | 5.8 (5.1, 6.1) | 16.3 (14.3, 18.2) |  |
| Hepatic failure | 31795 | 29044 (28679, 29232) | 2751 (2387, 2939) | 8.3 (7.2, 8.9) | 9.5 (8.3, 10.7) |  |
| LIHC | 32536 | 32138 (31744, 32341) | 398 (4, 601) | 1.2 (0.0, 1.8) | 1.2 (0.1, 2.3) |  |
| AP | 7272 | 5958 (5799, 6042) | 1314 (1154, 1397) | 4.0 (3.5, 4.2) | 22.1 (19.3, 24.9) |  |
| PC | 50931 | 51978 (51450, 52249) | -1047 (-1575, -776) | -3.2 (-4.7, -2.3) | -2.0 (-2.9, -1.2) |  |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; EC, esophageal cancer; GC, gastric cancer; CRC, colorectal cancer; ALD, alcohol liver disease; LIHC, liver and intrahepatic cancer; AP, acute pancreatitis; PC, pancreatic cancer.

a The contributing cause of death was adopted.

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

# Additional Table 5. Excess mortality associated with digestive related diseases from March 2022 to September 2022.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cause of death a** | **Observed deaths, No.** | **Expected deaths No. (95% CI)** | **Excess deaths**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk %**  **(95% CI) d** |
| **GI diseases** | | | | | |
| GI hemorrhage, NOS | 22877 | 19587 (19270, 19751) | 3290 (2973, 3454) | 9.9 (9.0, 10.4) | 16.8 (15.3, 18.3) |
| Ulcers | 4538 | 4121 (3988, 4191) | 417 (284, 487) | 1.3 (0.9, 1.5) | 10.1 (6.9, 13.3) |
| Paralytic ileus and intestine obstruction | 12122 | 11682 (11441, 11807) | 440 (199, 565) | 1.3 (0.6, 1.7) | 3.8 (1.9, 5.6) |
| Vascular disorder of intestine | 9308 | 9604 (9383, 9719) | -296 (-517, -181) | -0.9 (-1.6, -0.5) | -3.1 (-5.0, -1.1) |
| *C. difficile* colitis | 4494 | 2826 (2721, 2882) | 1668 (1562, 1724) | 5.0 (4.7, 5.2) | 59.0 (54.4, 63.7) |
| EC | 10157 | 10920 (10702, 11034) | -763 (-982, -650) | -2.3 (-3.0, -2.0) | -7.0 (-8.8, -5.2) |
| GC | 6892 | 7256 (7089, 7344) | -364 (-531, -277) | -1.1 (-1.6, -0.8) | -5.0 (-7.2, -2.8) |
| CRC | 35971 | 34953 (34517, 35177) | 1018 (583, 1242) | 3.1 (1.8, 3.7) | 2.9 (1.9, 4.0) |
| **Liver and pancreatic diseases** | | | | | |
| ALD | 21996 | 20231 (19945, 20378) | 1765 (1480, 1913) | 5.3 (4.5, 5.8) | 8.7 (7.3, 10.2) |
| Fibrosis/cirrhosis | 29715 | 29049 (28660, 29250) | 666 (277, 866) | 2.0 (0.8, 2.6) | 2.3 (1.1, 3.5) |
| Chronic hepatitis C | 6862 | 6210 (6048, 6294) | 652 (491, 737) | 2.0 (1.5, 2.2) | 10.5 (7.9, 13.1) |
| Hepatic failure | 17033 | 16618 (16342, 16761) | 415 (139, 557) | 1.3 (0.4, 1.7) | 2.5 (1.0, 4.0) |
| LIHC | 18436 | 18622 (18322, 18777) | -186 (-486, -31) | -0.6 (-1.5, -0.1) | -1.0 (-2.4, 0.4) |
| AP | 3875 | 3412 (3292, 3476) | 463 (342, 526) | 1.4 (1.0, 1.6) | 13.6 (10.0, 17.2) |
| PC | 29362 | 30402 (29999, 30610) | -1040 (-1444, -832) | -3.1 (-4.4, -2.5) | -3.4 (-4.5, -2.3) |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; EC, esophageal cancer; GC, gastric cancer; CRC, colorectal cancer; ALD, alcohol liver disease; LIHC, liver and intrahepatic cancer; AP, acute pancreatitis; PC, pancreatic cancer.

a The contributing cause of death was adopted.

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

# Additional Table 6. Excess mortality associated with selected digestive related diseases stratified by demographic factor from March 2020 to February 2021.

| **Cause of death a** | **Observed deaths, No.** | **Expected deaths No. (95% CI)** | **Excess deaths**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk % (95% CI) d** |
| --- | --- | --- | --- | --- | --- |
| **Gastrointestinal diseases** | | | | | |
| **GI hemorrhage, NOS** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 11338 | 8229 (8014, 8341) | 3109 (2893, 3221) | 16.0 (14.9, 16.6) | 37.8 (35.3, 40.3) |
| 65-84 years | 19895 | 15851 (15590, 15986) | 4044 (3783, 4179) | 86.8 (81.2, 89.7) | 25.5 (23.8, 27.3) |
| Sex |  |  |  |  |  |
| Female | 19424 | 15668 (15395, 15809) | 3756 (3484, 3897) | 22.6 (20.9, 23.4) | 24.0 (22.2, 25.7) |
| Male | 24347 | 19122 (18799, 19289) | 5225 (4901, 5392) | 32.0 (30.0, 33.0) | 27.3 (25.7, 28.9) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 31563 | 26173 (25796, 26367) | 5390 (5013, 5584) | 27.5 (25.6, 28.5) | 20.6 (19.3, 21.9) |
| NHB | 5609 | 4107 (3962, 4183) | 1502 (1357, 1578) | 37.4 (33.8, 39.3) | 36.6 (33.0, 40.2) |
| Hispanic | 4177 | 2664 (2563, 2718) | 1513 (1412, 1566) | 24.9 (23.2, 25.8) | 56.8 (52.1, 61.6) |
| **Ulcers** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 1272 | 1012 (911, 1066) | 260 (158, 313) | 1.3 (0.8, 1.6) | 25.7 (18.9, 32.7) |
| 65-84 years | 4050 | 3603 (3417, 3700) | 447 (261, 544) | 9.6 (5.6, 11.7) | 12.4 (9.0, 15.9) |
| Sex |  |  |  |  |  |
| Female | 3833 | 3400 (3281, 3462) | 433 (315, 496) | 2.6 (1.9, 3.0) | 12.7 (9.2, 16.3) |
| Male | 4354 | 3681 (3553, 3748) | 673 (545, 740) | 4.1 (3.3, 4.5) | 18.3 (14.8, 21.8) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 6146 | 5405 (5261, 5480) | 741 (597, 817) | 3.8 (3.0, 4.2) | 13.7 (10.9, 16.6) |
| NHB | 813 | 676 (625, 704) | 137 (86, 165) | 3.4 (2.1, 4.1) | 20.3 (12.1, 28.7) |
| Hispanic | 555 | 506 (462, 531) | 49 (5, 73) | 0.8 (0.1, 1.2) | 9.7 (0.7, 19.0) |
| ***C. difficile* colitis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 492 | 369 (323, 394) | 123 (78, 148) | 0.6 (0.4, 0.8) | 33.3 (21.8, 45.4) |
| 65-84 years | 4049 | 3508 (3372, 3579) | 541 (405, 612) | 11.6 (8.7, 13.1) | 15.4 (11.9, 19.0) |
| Sex |  |  |  |  |  |
| Female | 4183 | 3596 (3476, 3659) | 587 (468, 650) | 3.5 (2.8, 3.9) | 16.3 (12.8, 19.9) |
| Male | 3609 | 3020 (2912, 3077) | 589 (481, 646) | 3.6 (2.9, 4.0) | 19.5 (15.6, 23.4) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 6054 | 5156 (5005, 5236) | 898 (746, 977) | 4.6 (3.8, 5.0) | 17.4 (14.5, 20.4) |
| NHB | 791 | 617 (569, 644) | 174 (125, 201) | 4.3 (3.1, 5.0) | 28.2 (19.4, 37.3) |
| Hispanic | 509 | 508 (463, 532) | 1 (-43, 26) | 0.0 (-0.7, 0.4) | 0.2 (-8.3, 9.1) |
| **Colorectal cancer** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 18262 | 17887 (17579, 18046) | 375 (68, 534) | 1.9 (0.4, 2.8) | 2.1 (0.6, 3.6) |
| 65-84 years | 30758 | 29390 (29026, 29578) | 1368 (1004, 1556) | 29.4 (21.6, 33.4) | 4.7 (3.5, 5.8) |
| Sex |  |  |  |  |  |
| Female | 28988 | 28359 (27972, 28559) | 629 (242, 828) | 3.8 (1.5, 5.0) | 2.2 (1.0, 3.4) |
| Male | 34091 | 32646 (32288, 32831) | 1445 (1087, 1629) | 8.9 (6.7, 10.0) | 4.4 (3.3, 5.5) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 46441 | 45060 (44583, 45305) | 1381 (904, 1626) | 7.0 (4.6, 8.3) | 3.1 (2.1, 4.0) |
| NHB | 8377 | 7807 (7634, 7897) | 570 (397, 660) | 14.2 (9.9, 16.4) | 7.3 (5.0, 9.6) |
| Hispanic | 5134 | 4878 (4726, 4957) | 256 (104, 336) | 4.2 (1.7, 5.5) | 5.2 (2.4, 8.1) |
| **Liver and pancreatic diseases** | | | | | |
| **ALD** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 29470 | 23544 (23230, 23707) | 5926 (5611, 6088) | 30.6 (28.9, 31.4) | 25.2 (23.7, 26.6) |
| 65-84 years | 10239 | 8839 (8637, 8944) | 1400 (1198, 1505) | 30.1 (25.7, 32.3) | 15.8 (13.6, 18.1) |
| Sex |  |  |  |  |  |
| Female | 12334 | 9869 (9674, 9970) | 2465 (2271, 2567) | 14.8 (13.6, 15.4) | 25.0 (22.8, 27.2) |
| Male | 28024 | 23224 (22925, 23378) | 4800 (4502, 4955) | 29.4 (27.6, 30.4) | 20.7 (19.3, 22.1) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 27883 | 23459 (23159, 23614) | 4424 (4123, 4579) | 22.6 (21.0, 23.4) | 18.9 (17.5, 20.3) |
| NHB | 3229 | 2543 (2441, 2597) | 686 (584, 740) | 17.1 (14.5, 18.4) | 27.0 (22.6, 31.4) |
| Hispanic | 6429 | 5092 (4943, 5170) | 1337 (1189, 1415) | 22.0 (19.6, 23.3) | 26.3 (23.2, 29.4) |
| **Chronic hepatitis C** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 7388 | 6467 (6298, 6555) | 921 (752, 1009) | 4.8 (3.9, 5.2) | 14.2 (11.7, 16.9) |
| 65-84 years | 5948 | 4958 (4789, 5046) | 990 (821, 1078) | 21.2 (17.6, 23.1) | 20.0 (16.9, 23.0) |
| Sex |  |  |  |  |  |
| Female | 4341 | 3568 (3451, 3629) | 773 (656, 835) | 4.6 (3.9, 5.0) | 21.7 (18.1, 25.3) |
| Male | 10591 | 9260 (9071, 9358) | 1331 (1143, 1430) | 8.2 (7.0, 8.8) | 14.4 (12.2, 16.6) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 9277 | 8155 (7971, 8252) | 1122 (937, 1218) | 5.7 (4.8, 6.2) | 13.8 (11.5, 16.1) |
| NHB | 2798 | 2292 (2198, 2342) | 506 (412, 556) | 12.6 (10.2, 13.8) | 22.1 (17.6, 26.6) |
| Hispanic | 1914 | 1531 (1448, 1575) | 383 (300, 427) | 6.3 (4.9, 7.0) | 25.0 (19.5, 30.7) |
| **Fibrosis/cirrhosis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 21659 | 18741 (18394, 18920) | 2918 (2571, 3097) | 15.1 (13.3, 16.0) | 15.6 (14.0, 17.1) |
| 65-84 years | 26113 | 24411 (24091, 24576) | 1702 (1383, 1868) | 36.5 (29.7, 40.1) | 7.0 (5.7, 8.3) |
| Sex |  |  |  |  |  |
| Female | 21749 | 19800 (19514, 19947) | 1949 (1664, 2097) | 11.7 (10.0, 12.6) | 9.8 (8.4, 11.3) |
| Male | 30266 | 27489 (27156, 27661) | 2777 (2444, 2949) | 17.0 (15.0, 18.1) | 10.1 (8.9, 11.3) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 36387 | 33900 (33507, 34103) | 2487 (2093, 2690) | 12.7 (10.7, 13.7) | 7.3 (6.2, 8.4) |
| NHB | 4749 | 4236 (4096, 4310) | 513 (373, 586) | 12.8 (9.3, 14.6) | 12.1 (8.9, 15.3) |
| Hispanic | 8026 | 6462 (6296, 6548) | 1564 (1399, 1651) | 25.7 (23.0, 27.2) | 24.2 (21.5, 26.9) |
| **Hepatic failure** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 15128 | 13486 (13228, 13620) | 1642 (1383, 1776) | 8.5 (7.1, 9.2) | 12.2 (10.4, 14.0) |
| 65-84 years | 12805 | 12303 (12065, 12426) | 502 (264, 625) | 10.8 (5.7, 13.4) | 4.1 (2.3, 5.9) |
| Sex |  |  |  |  |  |
| Female | 13255 | 12512 (12293, 12626) | 743 (524, 857) | 4.5 (3.1, 5.1) | 5.9 (4.1, 7.7) |
| Male | 17182 | 15792 (15542, 15921) | 1390 (1140, 1520) | 8.5 (7.0, 9.3) | 8.8 (7.2, 10.4) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 21004 | 19872 (19591, 20017) | 1132 (851, 1278) | 5.8 (4.3, 6.5) | 5.7 (4.3, 7.1) |
| NHB | 3466 | 3137 (3027, 3195) | 329 (219, 387) | 8.2 (5.4, 9.6) | 10.5 (6.8, 14.2) |
| Hispanic | 4045 | 3491 (3375, 3552) | 554 (439, 616) | 9.1 (7.2, 10.1) | 15.9 (12.3, 19.5) |
| **Acute pancreatitis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 2094 | 1518 (1378, 1592) | 576 (435, 649) | 3.0 (2.2, 3.3) | 37.9 (32.1, 43.9) |
| 65-84 years | 2274 | 1671 (1497, 1761) | 603 (430, 694) | 12.9 (9.2, 14.9) | 36.1 (30.6, 41.7) |
| Sex |  |  |  |  |  |
| Female | 2806 | 2311 (2210, 2364) | 495 (394, 549) | 3.0 (2.4, 3.3) | 21.4 (17.0, 26.0) |
| Male | 4344 | 3485 (3354, 3553) | 859 (729, 928) | 5.3 (4.5, 5.7) | 24.6 (21.0, 28.4) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 5109 | 4188 (4053, 4259) | 921 (785, 992) | 4.7 (4.0, 5.1) | 22.0 (18.7, 25.4) |
| NHB | 994 | 766 (712, 795) | 228 (174, 258) | 5.7 (4.3, 6.4) | 29.8 (21.8, 38.0) |
| Hispanic | 635 | 605 (556, 631) | 30 (-18, 57) | 0.5 (-0.3, 0.9) | 5.0 (-3.0, 13.3) |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; ALD, alcohol liver disease; NHW, non-Hispanic White inhabitants; NHB, non-Hispanic Black inhabitants.

a The contributing cause of death was adopted.

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

e Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

# Additional Table 7. Excess mortality associated with selected digestive related diseases stratified by demographic factor from March 2021 to February 2022.

| **Cause of death a** | **Observed deaths, No.** | **Expected deaths No. (95% CI)** | **Excess deaths**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk % (95% CI) d** |
| --- | --- | --- | --- | --- | --- |
| **Gastrointestinal diseases** | | | | | |
| **GI hemorrhage, NOS** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 12229 | 8242 (8027, 8354) | 3987 (3771, 4099) | 20.6 (19.5, 21.1) | 48.4 (45.8, 51.0) |
| 65-84 years | 20833 | 16038 (15776, 16174) | 4795 (4532, 4931) | 102.9 (97.3, 105.8) | 29.9 (28.1, 31.7) |
| Sex |  |  |  |  |  |
| Female | 19867 | 15540 (15269, 15680) | 4327 (4056, 4468) | 26.0 (24.4, 26.8) | 27.8 (26.1, 29.6) |
| Male | 25154 | 19356 (19031, 19524) | 5798 (5473, 5966) | 35.5 (33.5, 36.6) | 30.0 (28.4, 31.6) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 32938 | 26125 (25749, 26319) | 6813 (6436, 7007) | 34.8 (32.8, 35.7) | 26.1 (24.7, 27.4) |
| NHB | 5523 | 4125 (3979, 4201) | 1398 (1252, 1474) | 34.8 (31.1, 36.7) | 33.9 (30.4, 37.4) |
| Hispanic | 4089 | 2651 (2550, 2705) | 1438 (1337, 1491) | 23.6 (22.0, 24.5) | 54.2 (49.6, 59.0) |
| **Ulcers** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 1287 | 1004 (903, 1058) | 283 (182, 336) | 1.5 (0.9, 1.7) | 28.2 (21.3, 35.3) |
| 65-84 years | 4314 | 3889 (3696, 3989) | 425 (232, 525) | 9.1 (5.0, 11.3) | 10.9 (7.6, 14.3) |
| Sex |  |  |  |  |  |
| Female | 3997 | 3521 (3401, 3585) | 476 (355, 539) | 2.9 (2.1, 3.2) | 13.5 (10.0, 17.1) |
| Male | 4588 | 3739 (3610, 3807) | 849 (720, 917) | 5.2 (4.4, 5.6) | 22.7 (19.2, 26.3) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 6333 | 5501 (5355, 5577) | 832 (687, 909) | 4.2 (3.5, 4.6) | 15.1 (12.3, 18.0) |
| NHB | 936 | 733 (680, 762) | 203 (150, 232) | 5.1 (3.7, 5.8) | 27.7 (19.6, 36.0) |
| Hispanic | 718 | 627 (578, 654) | 91 (42, 118) | 1.5 (0.7, 1.9) | 14.5 (6.3, 23.0) |
| ***C. difficile* colitis** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 518 | 320 (278, 344) | 198 (156, 221) | 1.0 (0.8, 1.1) | 61.9 (48.2, 76.1) |
| 65-84 years | 4620 | 3000 (2874, 3066) | 1620 (1495, 1686) | 34.8 (32.1, 36.2) | 54.0 (49.6, 58.5) |
| Sex |  |  |  |  |  |
| Female | 4411 | 2969 (2860, 3026) | 1442 (1334, 1500) | 8.7 (8.0, 9.0) | 48.6 (44.2, 53.0) |
| Male | 3836 | 2681 (2579, 2735) | 1155 (1054, 1209) | 7.1 (6.5, 7.4) | 43.1 (38.6, 47.6) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 6470 | 4341 (4202, 4414) | 2129 (1990, 2202) | 10.9 (10.2, 11.2) | 49.0 (45.4, 52.7) |
| NHB | 809 | 519 (474, 543) | 290 (246, 315) | 7.2 (6.1, 7.8) | 55.9 (45.3, 66.8) |
| Hispanic | 501 | 504 (460, 529) | -3 (-47, 21) | 0.0 (-0.8, 0.3) | -0.6 (-9.1, 8.3) |
| **Colorectal cancer** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 18618 | 18148 (17838, 18308) | 470 (160, 630) | 2.4 (0.8, 3.3) | 2.6 (1.1, 4.1) |
| 65-84 years | 31836 | 28953 (28591, 29139) | 2883 (2522, 3069) | 61.9 (54.1, 65.9) | 10.0 (8.8, 11.2) |
| Sex |  |  |  |  |  |
| Female | 29447 | 28275 (27889, 28475) | 1172 (785, 1371) | 7.0 (4.7, 8.2) | 4.1 (3.0, 5.3) |
| Male | 34476 | 32907 (32547, 33092) | 1569 (1210, 1755) | 9.6 (7.4, 10.8) | 4.8 (3.7, 5.9) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 47012 | 44813 (44337, 45057) | 2199 (1724, 2444) | 11.2 (8.8, 12.5) | 4.9 (4.0, 5.9) |
| NHB | 8234 | 7819 (7646, 7910) | 415 (241, 505) | 10.3 (6.0, 12.6) | 5.3 (3.0, 7.6) |
| Hispanic | 5320 | 5014 (4860, 5095) | 306 (152, 386) | 5.0 (2.5, 6.3) | 6.1 (3.3, 9.0) |
| **Liver and pancreatic diseases** | | | | | |
| **ALD** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 31526 | 24438 (24117, 24603) | 7088 (6768, 7254) | 36.6 (34.9, 37.4) | 29.0 (27.6, 30.4) |
| 65-84 years | 11048 | 9339 (9132, 9447) | 1709 (1501, 1816) | 36.7 (32.2, 39.0) | 18.3 (16.1, 20.5) |
| Sex |  |  |  |  |  |
| Female | 13056 | 10388 (10188, 10492) | 2668 (2468, 2772) | 16.0 (14.8, 16.6) | 25.7 (23.5, 27.8) |
| Male | 30202 | 24197 (23892, 24354) | 6005 (5700, 6163) | 36.8 (34.9, 37.8) | 24.8 (23.4, 26.2) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 29720 | 24537 (24229, 24695) | 5183 (4876, 5342) | 26.4 (24.9, 27.3) | 21.1 (19.8, 22.5) |
| NHB | 3576 | 2606 (2502, 2661) | 970 (867, 1025) | 24.1 (21.6, 25.5) | 37.2 (32.8, 41.8) |
| Hispanic | 6725 | 5338 (5186, 5417) | 1387 (1235, 1467) | 22.8 (20.3, 24.1) | 26.0 (23.0, 29.0) |
| **Chronic hepatitis C** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 6537 | 5532 (5376, 5614) | 1005 (849, 1087) | 5.2 (4.4, 5.6) | 18.2 (15.3, 21.0) |
| 65-84 years | 5658 | 4919 (4750, 5006) | 739 (571, 827) | 15.9 (12.3, 17.8) | 15.0 (12.0, 18.0) |
| Sex |  |  |  |  |  |
| Female | 4049 | 3225 (3113, 3283) | 824 (713, 883) | 4.9 (4.3, 5.3) | 25.6 (21.7, 29.4) |
| Male | 9697 | 8551 (8370, 8645) | 1146 (965, 1241) | 7.0 (5.9, 7.6) | 13.4 (11.2, 15.7) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 8752 | 7530 (7352, 7622) | 1222 (1045, 1315) | 6.2 (5.3, 6.7) | 16.2 (13.8, 18.7) |
| NHB | 2354 | 2046 (1957, 2093) | 308 (219, 355) | 7.7 (5.4, 8.8) | 15.1 (10.5, 19.7) |
| Hispanic | 1774 | 1334 (1257, 1376) | 440 (362, 481) | 7.2 (6.0, 7.9) | 33.0 (26.9, 39.2) |
| **Fibrosis/cirrhosis** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 22872 | 18805 (18457, 18984) | 4067 (3720, 4246) | 21.0 (19.2, 21.9) | 21.6 (20.1, 23.2) |
| 65-84 years | 28138 | 26015 (25684, 26185) | 2123 (1793, 2294) | 45.6 (38.5, 49.2) | 8.2 (6.9, 9.4) |
| Sex |  |  |  |  |  |
| Female | 23628 | 20885 (20591, 21036) | 2743 (2450, 2895) | 16.5 (14.7, 17.4) | 13.1 (11.7, 14.6) |
| Male | 31639 | 28714 (28373, 28889) | 2925 (2585, 3101) | 17.9 (15.8, 19.0) | 10.2 (9.0, 11.4) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 39376 | 35631 (35227, 35839) | 3745 (3342, 3953) | 19.1 (17.1, 20.2) | 10.5 (9.4, 11.6) |
| NHB | 4757 | 4405 (4262, 4479) | 352 (210, 427) | 8.8 (5.2, 10.6) | 8.0 (4.9, 11.1) |
| Hispanic | 8071 | 6535 (6369, 6622) | 1536 (1369, 1623) | 25.3 (22.5, 26.7) | 23.5 (20.8, 26.2) |
| **Hepatic failure** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 16197 | 13670 (13410, 13805) | 2527 (2266, 2662) | 13.0 (11.7, 13.7) | 18.5 (16.7, 20.3) |
| 65-84 years | 13273 | 12571 (12330, 12695) | 702 (462, 827) | 15.1 (9.9, 17.8) | 5.6 (3.8, 7.4) |
| Sex |  |  |  |  |  |
| Female | 13994 | 12903 (12681, 13019) | 1091 (868, 1206) | 6.6 (5.2, 7.2) | 8.5 (6.7, 10.3) |
| Male | 17801 | 15979 (15728, 16110) | 1822 (1570, 1952) | 11.2 (9.6, 12.0) | 11.4 (9.8, 13.0) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 22155 | 20128 (19846, 20275) | 2027 (1744, 2173) | 10.3 (8.9, 11.1) | 10.1 (8.6, 11.5) |
| NHB | 3526 | 3191 (3080, 3249) | 335 (224, 394) | 8.3 (5.6, 9.8) | 10.5 (6.9, 14.2) |
| Hispanic | 4070 | 3593 (3475, 3655) | 477 (360, 539) | 7.8 (5.9, 8.9) | 13.3 (9.8, 16.8) |
| **Acute pancreatitis** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 2178 | 1740 (1589, 1819) | 438 (287, 517) | 2.3 (1.5, 2.7) | 25.2 (20.0, 30.5) |
| 65-84 years | 2361 | 1659 (1486, 1749) | 702 (529, 792) | 15.1 (11.4, 17.0) | 42.3 (36.6, 48.1) |
| Sex |  |  |  |  |  |
| Female | 2913 | 2315 (2214, 2368) | 598 (497, 652) | 3.6 (3.0, 3.9) | 25.8 (21.3, 30.4) |
| Male | 4359 | 3615 (3483, 3685) | 744 (611, 813) | 4.6 (3.7, 5.0) | 20.6 (17.0, 24.2) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 5248 | 4213 (4077, 4284) | 1035 (900, 1106) | 5.3 (4.6, 5.6) | 24.6 (21.2, 28.0) |
| NHB | 891 | 755 (701, 784) | 136 (82, 166) | 3.4 (2.0, 4.1) | 18.0 (10.4, 25.9) |
| Hispanic | 644 | 686 (635, 714) | -42 (-93, -14) | -0.7 (-1.5, -0.2) | -6.1 (-13.2, 1.3) |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; ALD, alcohol liver disease; NHW, non-Hispanic White inhabitants; NHB, non-Hispanic Black inhabitants.

a The contributing cause of death was adopted.

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

e Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

# Additional Table 8. Excess mortality associated with selected digestive related diseases stratified by demographic from March 2022 to September 2022.

| **Cause of death a** | **Observed deaths, No.** | **Expected deaths No. (95% CI)** | **Excess deaths**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk % (95% CI) d** |
| --- | --- | --- | --- | --- | --- |
| **Gastrointestinal diseases** | | | | | |
| **GI hemorrhage, NOS** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 5647 | 4593 (4432, 4678) | 1054 (893, 1138) | 5.4 (4.6, 5.9) | 22.9 (19.8, 26.2) |
| 65-84 years | 10827 | 8972 (8776, 9074) | 1855 (1658, 1957) | 39.8 (35.6, 42.0) | 20.7 (18.4, 23.0) |
| Sex |  |  |  |  |  |
| Female | 10410 | 8649 (8446, 8754) | 1761 (1559, 1866) | 10.6 (9.4, 11.2) | 20.4 (18.1, 22.7) |
| Male | 12467 | 10824 (10580, 10950) | 1643 (1400, 1770) | 10.1 (8.6, 10.8) | 15.2 (13.2, 17.2) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 16813 | 14664 (14382, 14810) | 2149 (1867, 2295) | 11.0 (9.5, 11.7) | 14.7 (12.9, 16.4) |
| NHB | 2743 | 2293 (2184, 2350) | 450 (342, 507) | 11.2 (8.5, 12.6) | 19.6 (15.2, 24.1) |
| Hispanic | 2056 | 1444 (1370, 1484) | 612 (537, 652) | 10.1 (8.8, 10.7) | 42.4 (36.3, 48.6) |
| **Ulcers** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 597 | 540 (466, 580) | 57 (-17, 96) | 0.3 (-0.1, 0.5) | 10.6 (1.9, 19.6) |
| 65-84 years | 2341 | 2260 (2113, 2337) | 81 (-66, 158) | 1.7 (-1.4, 3.4) | 3.6 (-0.6, 7.8) |
| Sex |  |  |  |  |  |
| Female | 2146 | 1997 (1906, 2045) | 149 (59, 197) | 0.9 (0.4, 1.2) | 7.5 (3.0, 12.1) |
| Male | 2392 | 2100 (2003, 2151) | 292 (195, 343) | 1.8 (1.2, 2.1) | 13.9 (9.4, 18.5) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 3372 | 3122 (3012, 3180) | 250 (141, 308) | 1.3 (0.7, 1.6) | 8.0 (4.4, 11.7) |
| NHB | 467 | 397 (358, 418) | 70 (31, 92) | 1.7 (0.8, 2.3) | 17.6 (7.2, 28.5) |
| Hispanic | 403 | 361 (324, 382) | 42 (5, 63) | 0.7 (0.1, 1.0) | 11.6 (1.0, 22.8) |
| ***C. difficile* colitis** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 240 | 119 (94, 135) | 121 (95, 136) | 0.6 (0.5, 0.7) | 101.7 (77.0, 128.0) |
| 65-84 years | 2508 | 1496 (1408, 1544) | 1012 (923, 1059) | 21.7 (19.8, 22.7) | 67.6 (61.1, 74.3) |
| Sex |  |  |  |  |  |
| Female | 2517 | 1434 (1358, 1474) | 1083 (1008, 1124) | 6.5 (6.1, 6.7) | 75.5 (68.7, 82.4) |
| Male | 1977 | 1395 (1322, 1435) | 582 (509, 621) | 3.6 (3.1, 3.8) | 41.7 (35.5, 48.0) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 3475 | 2161 (2063, 2213) | 1314 (1216, 1366) | 6.7 (6.2, 7.0) | 60.8 (55.5, 66.2) |
| NHB | 481 | 259 (227, 277) | 222 (191, 240) | 5.5 (4.8, 6.0) | 85.7 (69.5, 102.7) |
| Hispanic | 273 | 273 (241, 292) | 0 (-33, 18) | 0.0 (-0.5, 0.3) | 0.0 (-11.5, 12.2) |
| **Colorectal cancer** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 10609 | 10469 (10234, 10591) | 140 (-96, 262) | 0.7 (-0.5, 1.4) | 1.3 (-0.6, 3.3) |
| 65-84 years | 17844 | 16119 (15849, 16259) | 1725 (1455, 1864) | 37.0 (31.2, 40.0) | 10.7 (9.1, 12.3) |
| Sex |  |  |  |  |  |
| Female | 16714 | 16014 (15723, 16165) | 700 (409, 850) | 4.2 (2.5, 5.1) | 4.4 (2.8, 6.0) |
| Male | 19257 | 18725 (18454, 18866) | 532 (261, 672) | 3.3 (1.6, 4.1) | 2.8 (1.4, 4.3) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 26457 | 25469 (25111, 25654) | 988 (629, 1172) | 5.0 (3.2, 6.0) | 3.9 (2.6, 5.1) |
| NHB | 4525 | 4431 (4300, 4499) | 94 (-36, 163) | 2.3 (-0.9, 4.1) | 2.1 (-0.8, 5.1) |
| Hispanic | 3073 | 2885 (2768, 2946) | 188 (72, 250) | 3.1 (1.2, 4.1) | 6.5 (2.8, 10.3) |
| **Liver and pancreatic diseases** | | | | | |
| **ALD** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 15515 | 14231 (13986, 14358) | 1284 (1039, 1411) | 6.6 (5.4, 7.3) | 9.0 (7.3, 10.7) |
| 65-84 years | 6061 | 5421 (5262, 5503) | 640 (482, 723) | 13.7 (10.3, 15.5) | 11.8 (9.0, 14.6) |
| Sex |  |  |  |  |  |
| Female | 6773 | 6068 (5915, 6147) | 705 (553, 785) | 4.2 (3.3, 4.7) | 11.6 (9.0, 14.3) |
| Male | 15223 | 14075 (13843, 14196) | 1148 (915, 1268) | 7.0 (5.6, 7.8) | 8.2 (6.4, 9.9) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 15320 | 14456 (14220, 14578) | 864 (628, 986) | 4.4 (3.2, 5.0) | 6.0 (4.3, 7.7) |
| NHB | 1667 | 1503 (1424, 1545) | 164 (85, 206) | 4.1 (2.1, 5.1) | 10.9 (5.7, 16.3) |
| Hispanic | 3515 | 3054 (2939, 3114) | 461 (347, 522) | 7.6 (5.7, 8.6) | 15.1 (11.3, 18.9) |
| **Chronic hepatitis C** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 2824 | 2764 (2654, 2822) | 60 (-50, 118) | 0.3 (-0.3, 0.6) | 2.2 (-1.6, 6.0) |
| 65-84 years | 3187 | 2696 (2572, 2762) | 491 (366, 556) | 10.5 (7.9, 11.9) | 18.2 (14.1, 22.4) |
| Sex |  |  |  |  |  |
| Female | 2046 | 1653 (1574, 1696) | 393 (313, 435) | 2.4 (1.9, 2.6) | 23.8 (18.5, 29.2) |
| Male | 4816 | 4533 (4401, 4602) | 283 (151, 352) | 1.7 (0.9, 2.2) | 6.2 (3.3, 9.3) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 4424 | 4003 (3873, 4071) | 421 (292, 489) | 2.1 (1.5, 2.5) | 10.5 (7.3, 13.8) |
| NHB | 1241 | 1060 (996, 1095) | 181 (117, 215) | 4.5 (2.9, 5.3) | 17.1 (10.7, 23.7) |
| Hispanic | 800 | 665 (610, 695) | 135 (80, 165) | 2.2 (1.3, 2.7) | 20.3 (12.1, 28.8) |
| **Fibrosis/cirrhosis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 11260 | 10556 (10296, 10691) | 704 (444, 839) | 3.6 (2.3, 4.3) | 6.7 (4.7, 8.6) |
| 65-84 years | 15954 | 15283 (15029, 15414) | 671 (418, 803) | 14.4 (9.0, 17.2) | 4.4 (2.8, 6.0) |
| Sex |  |  |  |  |  |
| Female | 12813 | 12228 (12004, 12345) | 585 (360, 701) | 3.5 (2.2, 4.2) | 4.8 (3.0, 6.6) |
| Male | 16902 | 16661 (16402, 16795) | 241 (-18, 375) | 1.5 (-0.1, 2.3) | 1.4 (-0.1, 3.0) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 21265 | 20962 (20652, 21122) | 303 (-6, 463) | 1.5 (0.0, 2.4) | 1.4 (0.1, 2.8) |
| NHB | 2459 | 2556 (2447, 2614) | -97 (-206, -40) | -2.4 (-5.1, -1.0) | -3.8 (-7.6, 0.0) |
| Hispanic | 4479 | 3650 (3525, 3715) | 829 (705, 895) | 13.6 (11.6, 14.7) | 22.7 (19.1, 26.3) |
| **Hepatic failure** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 8149 | 7766 (7570, 7868) | 383 (186, 485) | 2.0 (1.0, 2.5) | 4.9 (2.7, 7.2) |
| 65-84 years | 7448 | 7183 (7001, 7277) | 265 (84, 360) | 5.7 (1.8, 7.7) | 3.7 (1.3, 6.1) |
| Sex |  |  |  |  |  |
| Female | 7604 | 7456 (7287, 7545) | 148 (-22, 236) | 0.9 (-0.1, 1.4) | 2.0 (-0.3, 4.3) |
| Male | 9429 | 9073 (8884, 9172) | 356 (167, 455) | 2.2 (1.0, 2.8) | 3.9 (1.8, 6.0) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 11820 | 11539 (11325, 11650) | 281 (67, 392) | 1.4 (0.3, 2.0) | 2.4 (0.6, 4.3) |
| NHB | 1889 | 1824 (1740, 1868) | 65 (-18, 110) | 1.6 (-0.4, 2.7) | 3.6 (-1.1, 8.3) |
| Hispanic | 2228 | 2037 (1949, 2084) | 191 (102, 238) | 3.1 (1.7, 3.9) | 9.4 (4.9, 14.0) |
| **Acute pancreatitis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 902 | 1065 (947, 1127) | -163 (-281, -101) | -0.8 (-1.4, -0.5) | -15.3 (-20.7, -9.7) |
| 65-84 years | 1443 | 879 (754, 946) | 564 (438, 630) | 12.1 (9.4, 13.5) | 64.2 (55.8, 72.7) |
| Sex |  |  |  |  |  |
| Female | 1604 | 1319 (1243, 1360) | 285 (209, 326) | 1.7 (1.3, 2.0) | 21.6 (15.7, 27.6) |
| Male | 2271 | 2078 (1977, 2131) | 193 (92, 246) | 1.2 (0.6, 1.5) | 9.3 (4.8, 13.8) |
| Race/ethnicitye |  |  |  |  |  |
| NHW | 2809 | 2392 (2290, 2446) | 417 (314, 471) | 2.1 (1.6, 2.4) | 17.4 (13.1, 21.8) |
| NHB | 497 | 450 (409, 473) | 47 (5, 70) | 1.2 (0.1, 1.7) | 10.4 (0.9, 20.4) |
| Hispanic | 303 | 375 (337, 396) | -72 (-110, -51) | -1.2 (-1.8, -0.8) | -19.2 (-28.0, -9.8) |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; ALD, alcohol liver disease; NHW, non-Hispanic White inhabitants; NHB, non-Hispanic Black inhabitants.

a The contributing cause of death was adopted.

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

e Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

# Additional Table 9. The estimated excess mortality of gastrointestinal hemorrhage by state from March 2020 to September 2022.

| **State** | **Abbreviation** | **Observed deaths, No..** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) a** | **Excess mortality**  **(95% CI) b** | **Excess risk % (95% CI) c** |
| --- | --- | --- | --- | --- | --- | --- |
| Alabama | AL | 1528 | 1385 (1312, 1425) | 143 (70, 182) | 28.6 (14.0, 36.4) | 10.3 (4.9, 15.9) |
| Arkansas | AR | 795 | 594 (546, 620) | 201 (153, 227) | 66.9 (50.9, 75.5) | 33.8 (24.7, 43.3) |
| Arizona | AZ | 2069 | 1469 (1394, 1510) | 600 (524, 640) | 84.8 (74.0, 90.4) | 40.8 (34.8, 47.0) |
| California | CA | 10265 | 8271 (8086, 8367) | 1994 (1809, 2091) | 50.5 (45.8, 53.0) | 24.1 (21.7, 26.5) |
| Colorado | CO | 2299 | 1822 (1739, 1867) | 477 (393, 521) | 83.3 (68.7, 91.0) | 26.2 (21.1, 31.4) |
| Connecticut | CT | 798 | 787 (732, 817) | 11 (-44, 41) | 3.1 (-12.2, 11.4) | 1.4 (-5.5, 8.6) |
| Florida | FL | 7704 | 6528 (6370, 6611) | 1176 (1017, 1259) | 55.1 (47.7, 59.0) | 18.0 (15.4, 20.7) |
| Georgia | GA | 3033 | 2410 (2312, 2462) | 623 (525, 675) | 58.6 (49.4, 63.5) | 25.9 (21.4, 30.4) |
| Iowa | IA | 827 | 947 (887, 980) | -120 (-180, -87) | -37.7 (-56.6, -27.4) | -12.7 (-18.5, -6.6) |
| Illinois | IL | 3416 | 2689 (2577, 2748) | 727 (616, 786) | 56.7 (48.0, 61.3) | 27.0 (22.8, 31.3) |
| Indiana | IN | 2684 | 2495 (2397, 2547) | 189 (91, 241) | 28.0 (13.5, 35.7) | 7.6 (3.5, 11.7) |
| Kansas | KS | 504 | 574 (527, 600) | -70 (-117, -44) | -23.9 (-39.9, -15.0) | -12.2 (-19.7, -4.4) |
| Kentucky | KY | 2215 | 2093 (2003, 2140) | 122 (33, 170) | 27.1 (7.3, 37.8) | 5.8 (1.5, 10.3) |
| Louisiana | LA | 916 | 924 (864, 956) | -8 (-68, 24) | -1.7 (-14.6, 5.2) | -0.9 (-7.2, 5.7) |
| Massachusetts | MA | 2307 | 2249 (2156, 2299) | 58 (-35, 107) | 8.3 (-5.0, 15.3) | 2.6 (-1.6, 6.8) |
| Maryland | MD | 2356 | 1712 (1631, 1755) | 644 (563, 688) | 104.7 (91.6, 111.9) | 37.6 (32.1, 43.2) |
| Michigan | MI | 3505 | 3247 (3129, 3309) | 258 (140, 320) | 25.6 (13.9, 31.8) | 7.9 (4.4, 11.5) |
| Minnesota | MN | 1802 | 1555 (1478, 1597) | 247 (169, 288) | 43.6 (29.8, 50.8) | 15.9 (10.6, 21.3) |
| Missouri | MO | 2065 | 1383 (1310, 1422) | 682 (609, 721) | 111.0 (99.2, 117.4) | 49.3 (42.9, 55.8) |
| Mississippi | MS | 753 | 614 (566, 641) | 139 (90, 166) | 46.8 (30.3, 55.9) | 22.6 (14.0, 31.6) |
| North Carolina | NC | 3397 | 3028 (2920, 3085) | 369 (261, 426) | 35.6 (25.2, 41.1) | 12.2 (8.4, 16.0) |
| New Jersey | NJ | 3270 | 2703 (2601, 2757) | 567 (465, 621) | 61.4 (50.4, 67.3) | 21.0 (16.9, 25.2) |
| New Mexico | NM | 385 | 382 (343, 403) | 3 (-35, 25) | 1.4 (-16.6, 11.9) | 0.8 (-9.0, 11.1) |
| New York | NY | 5440 | 4393 (4248, 4469) | 1047 (902, 1123) | 52.1 (44.8, 55.8) | 23.8 (20.6, 27.1) |
| Ohio | OH | 4207 | 3219 (3096, 3284) | 988 (865, 1053) | 83.9 (73.5, 89.5) | 30.7 (26.8, 34.7) |
| Oklahoma | OK | 1531 | 1053 (989, 1087) | 478 (415, 513) | 121.1 (105.1, 129.9) | 45.4 (38.2, 52.8) |
| Oregon | OR | 1337 | 1109 (1044, 1145) | 228 (162, 263) | 54.2 (38.5, 62.5) | 20.6 (14.2, 27.1) |
| Pennsylvania | PA | 5350 | 4124 (3991, 4194) | 1226 (1093, 1296) | 94.5 (84.3, 99.9) | 29.7 (26.3, 33.2) |
| South Carolina | SC | 2396 | 2027 (1939, 2074) | 369 (280, 416) | 72.7 (55.1, 81.9) | 18.2 (13.5, 23.0) |
| Tennessee | TN | 2797 | 2573 (2474, 2626) | 224 (124, 277) | 32.7 (18.1, 40.4) | 8.7 (4.7, 12.8) |
| Texas | TX | 8782 | 6257 (6102, 6338) | 2525 (2370, 2606) | 87.5 (82.1, 90.3) | 40.4 (37.4, 43.3) |
| Virginia | VA | 2467 | 1834 (1750, 1879) | 633 (549, 678) | 73.8 (64.0, 79.0) | 34.5 (29.3, 39.9) |
| Washington | WA | 2927 | 2564 (2459, 2620) | 363 (257, 418) | 47.7 (33.7, 54.9) | 14.2 (10.1, 18.3) |
| West Virginia | WV | 221 | 237 (207, 254) | -16 (-46, 1) | -8.9 (-25.5, 0.6) | -6.8 (-18.6, 5.9) |
| Wisconsin | WI | 2326 | 1917 (1831, 1962) | 409 (323, 455) | 69.7 (55.0, 77.5) | 21.3 (16.5, 26.3) |

Abbreviation: CI, confidence interval

Note: Gastrointestinal hemorrhage was the contributing causes of death.

a Excess death number estimated by subtract the expected number from the observed number of death.

b Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

c Excess risk was calculated as the ratio of the excess-to-expected number of death.

# Additional Table 10. The estimated excess mortality of colorectal cancer by state from March 2020 to September 2022.

| **State** | **Abbreviation** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) a** | **Excess mortality**  **(95% CI) b** | **Excess risk % (95% CI) c** |
| --- | --- | --- | --- | --- | --- | --- |
| Alabama | AL | 2745 | 2495 (2385, 2554) | 250 (139, 308) | 50.0 (27.8, 61.6) | 10.0 (5.9, 14.2) |
| Arkansas | AR | 1667 | 2008 (1920, 2055) | -341 (-429, -294) | -113.4 (-142.7, -97.8) | -17.0 (-20.9, -12.9) |
| Arizona | AZ | 3446 | 3134 (3009, 3199) | 312 (188, 378) | 44.1 (26.6, 53.4) | 10.0 (6.3, 13.7) |
| California | CA | 16790 | 16497 (16235, 16633) | 293 (31, 429) | 7.4 (0.8, 10.9) | 1.8 (0.2, 3.3) |
| Colorado | CO | 2395 | 2107 (2017, 2154) | 288 (199, 336) | 50.3 (34.8, 58.7) | 13.7 (9.2, 18.3) |
| Connecticut | CT | 1159 | 1158 (1092, 1194) | 1 (-66, 37) | 0.3 (-18.3, 10.3) | 0.1 (-5.6, 5.9) |
| Florida | FL | 11901 | 10828 (10605, 10944) | 1073 (849, 1189) | 50.3 (39.8, 55.7) | 9.9 (7.9, 11.9) |
| Georgia | GA | 5014 | 4624 (4490, 4694) | 390 (257, 460) | 36.7 (24.2, 43.3) | 8.4 (5.5, 11.5) |
| Iowa | IA | 1645 | 1515 (1439, 1556) | 130 (54, 171) | 40.9 (17.0, 53.8) | 8.6 (3.4, 13.9) |
| Idaho | ID | 218 | 194 (166, 209) | 24 (-3, 40) | 13.2 (-1.7, 22.1) | 12.4 (-2.1, 27.8) |
| Illinois | IL | 6242 | 6097 (5926, 6187) | 145 (-27, 234) | 11.3 (-2.1, 18.3) | 2.4 (-0.1, 4.9) |
| Indiana | IN | 3763 | 4206 (4074, 4275) | -443 (-574, -374) | -65.6 (-85.0, -55.4) | -10.5 (-13.4, -7.7) |
| Kansas | KS | 1286 | 1128 (1062, 1163) | 158 (92, 194) | 53.9 (31.4, 66.2) | 14.0 (7.9, 20.3) |
| Kentucky | KY | 2934 | 2685 (2569, 2747) | 249 (132, 310) | 55.4 (29.4, 69.0) | 9.3 (5.4, 13.3) |
| Louisiana | LA | 2468 | 2435 (2338, 2486) | 33 (-63, 85) | 7.1 (-13.5, 18.3) | 1.4 (-2.6, 5.4) |
| Massachusetts | MA | 2756 | 2791 (2688, 2846) | -35 (-139, 19) | -5.0 (-19.9, 2.7) | -1.3 (-4.9, 2.5) |
| Maryland | MD | 3115 | 3174 (3063, 3232) | -59 (-169, 0) | -9.6 (-27.5, 0.0) | -1.9 (-5.3, 1.6) |
| Maine | ME | 104 | 162 (137, 177) | -58 (-83, -43) | -42.7 (-61.2, -31.7) | -35.8 (-47.5, -22.9) |
| Michigan | MI | 5364 | 5110 (4967, 5185) | 254 (111, 329) | 25.2 (11.0, 32.7) | 5.0 (2.2, 7.8) |
| Minnesota | MN | 2649 | 2675 (2573, 2728) | -26 (-127, 28) | -4.6 (-22.4, 4.9) | -1.0 (-4.7, 2.8) |
| Missouri | MO | 3369 | 2870 (2762, 2927) | 499 (392, 556) | 81.3 (63.8, 90.5) | 17.4 (13.5, 21.4) |
| Mississippi | MS | 1976 | 2039 (1951, 2086) | -63 (-152, -16) | -21.2 (-51.2, -5.4) | -3.1 (-7.3, 1.2) |
| North Carolina | NC | 4913 | 4991 (4853, 5064) | -78 (-217, -6) | -7.5 (-20.9, -0.6) | -1.6 (-4.3, 1.2) |
| Nebraska | NE | 527 | 585 (538, 611) | -58 (-106, -32) | -29.7 (-54.3, -16.4) | -9.9 (-17.4, -2.1) |
| New Jersey | NJ | 4315 | 4107 (3982, 4173) | 208 (82, 274) | 22.5 (8.9, 29.7) | 5.1 (2.0, 8.2) |
| New Mexico | NM | 382 | 349 (312, 369) | 33 (-3, 54) | 15.6 (-1.4, 25.6) | 9.5 (-1.2, 20.7) |
| Nevada | NV | 1178 | 1199 (1131, 1235) | -21 (-89, 16) | -6.9 (-29.1, 5.2) | -1.8 (-7.3, 3.9) |
| New York | NY | 9002 | 8856 (8663, 8957) | 146 (-48, 246) | 7.3 (-2.4, 12.2) | 1.6 (-0.4, 3.8) |
| Ohio | OH | 6471 | 5901 (5751, 5980) | 570 (419, 649) | 48.4 (35.6, 55.1) | 9.7 (7.0, 12.3) |
| Oklahoma | OK | 2467 | 2122 (2028, 2172) | 345 (250, 395) | 87.4 (63.3, 100.0) | 16.3 (11.7, 20.9) |
| Oregon | OR | 2120 | 2040 (1951, 2087) | 80 (-9, 127) | 19.0 (-2.1, 30.2) | 3.9 (-0.5, 8.4) |
| Pennsylvania | PA | 7290 | 6763 (6594, 6851) | 527 (358, 615) | 40.6 (27.6, 47.4) | 7.8 (5.3, 10.3) |
| South Carolina | SC | 2870 | 2974 (2867, 3030) | -104 (-210, -47) | -20.5 (-41.3, -9.3) | -3.5 (-7.0, 0.1) |
| Tennessee | TN | 3901 | 3879 (3757, 3944) | 22 (-100, 86) | 3.2 (-14.6, 12.5) | 0.6 (-2.6, 3.7) |
| Texas | TX | 12798 | 12225 (12004, 12340) | 573 (351, 688) | 19.9 (12.2, 23.8) | 4.7 (2.9, 6.5) |
| Virginia | VA | 4060 | 4152 (4016, 4224) | -92 (-229, -21) | -10.7 (-26.7, -2.4) | -2.2 (-5.2, 0.8) |
| Washington | WA | 3424 | 3097 (2988, 3154) | 327 (218, 385) | 42.9 (28.6, 50.5) | 10.6 (6.9, 14.3) |
| West Virginia | WV | 877 | 1053 (989, 1087) | -176 (-240, -142) | -97.7 (-133.3, -78.8) | -16.7 (-22.1, -11.1) |
| Wisconsin | WI | 2754 | 2384 (2289, 2435) | 370 (274, 420) | 63.0 (46.7, 71.5) | 15.5 (11.2, 19.9) |

Abbreviation: CI, confidence interval

Note: Colorectal cancer was the contributing causes of death.

a Excess death number estimated by subtract the expected number from the observed number of death.

b Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

c Excess risk was calculated as the ratio of the excess-to-expected number of death.

# Additional Table 11. The estimated excess mortality of alcoholic liver disease by state from March 2020 to September 2022.

| **State** | **Abbreviation** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) a** | **Excess mortality**  **(95% CI) b** | **Excess risk % (95% CI) c** |
| --- | --- | --- | --- | --- | --- | --- |
| Alabama | AL | 696 | 638 (589, 665) | 58 (8, 85) | 11.6 (1.6, 17.0) | 9.1 (1.1, 17.3) |
| Arizona | AZ | 3093 | 2258 (2165, 2308) | 835 (741, 884) | 118.0 (104.7, 124.9) | 37.0 (32.2, 41.8) |
| California | CA | 16263 | 13315 (13077, 13438) | 2948 (2710, 3072) | 74.7 (68.7, 77.9) | 22.1 (20.3, 24.0) |
| Colorado | CO | 3215 | 2717 (2615, 2771) | 498 (396, 552) | 87.0 (69.2, 96.4) | 18.3 (14.3, 22.5) |
| Florida | FL | 7001 | 5471 (5326, 5547) | 1530 (1385, 1606) | 71.7 (64.9, 75.3) | 28.0 (25.0, 31.0) |
| Georgia | GA | 2212 | 2122 (2032, 2170) | 90 (0, 138) | 8.5 (0.0, 13.0) | 4.2 (-0.1, 8.6) |
| Iowa | IA | 396 | 469 (427, 493) | -73 (-115, -49) | -23.0 (-36.2, -15.4) | -15.6 (-23.7, -7.0) |
| Illinois | IL | 2784 | 2474 (2377, 2526) | 310 (212, 361) | 24.2 (16.5, 28.2) | 12.5 (8.4, 16.7) |
| Indiana | IN | 2105 | 1993 (1905, 2039) | 112 (25, 159) | 16.6 (3.7, 23.6) | 5.6 (1.2, 10.2) |
| Kentucky | KY | 1043 | 1014 (952, 1048) | 29 (-34, 63) | 6.5 (-7.6, 14.0) | 2.9 (-3.3, 9.2) |
| Louisiana | LA | 433 | 308 (273, 327) | 125 (91, 145) | 26.8 (19.5, 31.1) | 40.6 (27.7, 54.1) |
| Massachusetts | MA | 1478 | 1370 (1297, 1409) | 108 (36, 147) | 15.4 (5.1, 21.0) | 7.9 (2.5, 13.5) |
| Maryland | MD | 924 | 801 (745, 831) | 123 (68, 154) | 20.0 (11.1, 25.0) | 15.4 (8.0, 22.9) |
| Michigan | MI | 3199 | 2432 (2335, 2483) | 767 (670, 818) | 76.2 (66.6, 81.3) | 31.5 (27.0, 36.1) |
| Minnesota | MN | 2463 | 1871 (1786, 1916) | 592 (508, 638) | 104.4 (89.6, 112.5) | 31.6 (26.5, 36.9) |
| Missouri | MO | 1068 | 957 (896, 990) | 111 (51, 144) | 18.1 (8.3, 23.4) | 11.6 (5.0, 18.4) |
| North Carolina | NC | 2918 | 2145 (2055, 2194) | 773 (682, 821) | 74.6 (65.8, 79.2) | 36.0 (31.1, 41.0) |
| New Jersey | NJ | 1101 | 1052 (989, 1087) | 49 (-15, 83) | 5.3 (-1.6, 9.0) | 4.7 (-1.4, 10.9) |
| New Mexico | NM | 1566 | 1143 (1077, 1179) | 423 (357, 459) | 200.5 (169.2, 217.6) | 37.0 (30.3, 43.9) |
| Nevada | NV | 856 | 662 (612, 690) | 194 (143, 221) | 63.4 (46.7, 72.2) | 29.3 (20.8, 38.1) |
| New York | NY | 3562 | 2755 (2651, 2809) | 807 (704, 862) | 40.1 (35.0, 42.9) | 29.3 (25.1, 33.6) |
| Ohio | OH | 3398 | 2897 (2792, 2953) | 501 (395, 556) | 42.6 (33.6, 47.2) | 17.3 (13.4, 21.3) |
| Oklahoma | OK | 1827 | 1700 (1619, 1743) | 127 (46, 170) | 32.2 (11.7, 43.1) | 7.5 (2.6, 12.5) |
| Oregon | OR | 2411 | 1940 (1854, 1986) | 471 (385, 517) | 112.0 (91.5, 122.9) | 24.3 (19.4, 29.3) |
| Pennsylvania | PA | 2745 | 2454 (2357, 2506) | 291 (194, 342) | 22.4 (15.0, 26.4) | 11.9 (7.7, 16.1) |
| South Carolina | SC | 1801 | 1651 (1571, 1693) | 150 (71, 193) | 29.5 (14.0, 38.0) | 9.1 (4.1, 14.2) |
| Tennessee | TN | 2691 | 2390 (2294, 2441) | 301 (205, 352) | 43.9 (29.9, 51.3) | 12.6 (8.4, 16.9) |
| Texas | TX | 7876 | 6972 (6797, 7063) | 904 (729, 995) | 31.3 (25.3, 34.5) | 13.0 (10.5, 15.5) |
| Virginia | VA | 1624 | 1449 (1374, 1489) | 175 (101, 215) | 20.4 (11.8, 25.1) | 12.1 (6.7, 17.6) |
| Washington | WA | 3884 | 3444 (3327, 3505) | 440 (324, 502) | 57.8 (42.5, 65.9) | 12.8 (9.3, 16.4) |
| Wisconsin | WI | 2111 | 1892 (1807, 1938) | 219 (134, 264) | 37.3 (22.8, 45.0) | 11.6 (6.9, 16.4) |

Abbreviation: CI, confidence interval

Note: Alcoholic liver disease was the contributing causes of death.

a Excess death number estimated by subtract the expected number from the observed number of death.

b Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

c Excess risk was calculated as the ratio of the excess-to-expected number of death.

# Additional Table 12. The estimated excess mortality of hepatic fibrosis/cirrhosis by state from March 2020 to September 2022.

| **State** | **Abbreviation** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) a** | **Excess mortality**  **(95% CI) b** | **Excess risk % (95% CI) c** |
| --- | --- | --- | --- | --- | --- | --- |
| Alabama | AL | 2639 | 2430 (2334, 2482) | 209 (112, 260) | 41.8 (22.4, 52.0) | 8.6 (4.5, 12.8) |
| Arkansas | AR | 1405 | 1436 (1362, 1476) | -31 (-105, 9) | -10.3 (-34.9, 3.0) | -2.2 (-7.2, 3.0) |
| Arizona | AZ | 3559 | 2815 (2705, 2873) | 744 (633, 802) | 105.1 (89.4, 113.3) | 26.4 (22.3, 30.6) |
| California | CA | 13299 | 12278 (12053, 12395) | 1021 (795, 1138) | 25.9 (20.1, 28.8) | 8.3 (6.5, 10.2) |
| Colorado | CO | 2193 | 2087 (1997, 2134) | 106 (17, 154) | 18.5 (3.0, 26.9) | 5.1 (0.7, 9.5) |
| Connecticut | CT | 715 | 767 (712, 796) | -52 (-106, -22) | -14.4 (-29.4, -6.1) | -6.8 (-13.5, 0.2) |
| Florida | FL | 9559 | 8356 (8177, 8449) | 1203 (1024, 1296) | 56.4 (48.0, 60.7) | 14.4 (12.1, 16.7) |
| Georgia | GA | 3758 | 2876 (2770, 2931) | 882 (777, 938) | 83.0 (73.1, 88.3) | 30.7 (26.5, 34.9) |
| Iowa | IA | 522 | 717 (664, 746) | -195 (-247, -166) | -61.3 (-77.7, -52.2) | -27.2 (-33.3, -20.8) |
| Illinois | IL | 4321 | 4106 (3969, 4178) | 215 (78, 287) | 16.8 (6.1, 22.4) | 5.2 (2.1, 8.4) |
| Indiana | IN | 3271 | 2983 (2876, 3040) | 288 (181, 344) | 42.7 (26.8, 51.0) | 9.7 (5.9, 13.4) |
| Kansas | KS | 447 | 570 (523, 595) | -123 (-169, -97) | -41.9 (-57.6, -33.1) | -21.6 (-28.7, -14.1) |
| Kentucky | KY | 3070 | 2874 (2766, 2932) | 196 (87, 253) | 43.6 (19.4, 56.3) | 6.8 (3.1, 10.6) |
| Louisiana | LA | 1544 | 1591 (1513, 1633) | -47 (-125, -5) | -10.1 (-26.8, -1.1) | -3.0 (-7.7, 1.9) |
| Massachusetts | MA | 2488 | 2169 (2077, 2217) | 319 (228, 368) | 45.6 (32.6, 52.6) | 14.7 (10.2, 19.3) |
| Maryland | MD | 2169 | 2127 (2036, 2175) | 42 (-48, 90) | 6.8 (-7.8, 14.6) | 2.0 (-2.3, 6.3) |
| Michigan | MI | 4123 | 3636 (3518, 3699) | 487 (368, 549) | 48.4 (36.6, 54.6) | 13.4 (10.0, 16.9) |
| Minnesota | MN | 1938 | 1850 (1766, 1895) | 88 (3, 133) | 15.5 (0.5, 23.5) | 4.8 (0.1, 9.5) |
| Missouri | MO | 2511 | 2006 (1918, 2052) | 505 (418, 552) | 82.2 (68.1, 89.9) | 25.2 (20.3, 30.1) |
| Mississippi | MS | 785 | 759 (705, 789) | 26 (-28, 55) | 8.8 (-9.4, 18.5) | 3.4 (-3.7, 10.8) |
| North Carolina | NC | 4853 | 5077 (4933, 5152) | -224 (-367, -148) | -21.6 (-35.4, -14.3) | -4.4 (-7.1, -1.7) |
| New Jersey | NJ | 2814 | 2465 (2365, 2518) | 349 (249, 402) | 37.8 (27.0, 43.5) | 14.2 (10.0, 18.4) |
| New Mexico | NM | 1380 | 1248 (1179, 1285) | 132 (63, 169) | 62.6 (29.9, 80.1) | 10.6 (4.8, 16.5) |
| Nevada | NV | 593 | 436 (395, 459) | 157 (116, 180) | 51.3 (37.9, 58.8) | 36.0 (25.3, 47.2) |
| New York | NY | 5012 | 4859 (4723, 4931) | 153 (16, 225) | 7.6 (0.8, 11.2) | 3.1 (0.3, 6.0) |
| Ohio | OH | 5331 | 5203 (5050, 5284) | 128 (-26, 208) | 10.9 (-2.2, 17.7) | 2.5 (-0.3, 5.2) |
| Oklahoma | OK | 2472 | 2229 (2136, 2278) | 243 (151, 292) | 61.5 (38.2, 74.0) | 10.9 (6.6, 15.3) |
| Oregon | OR | 1677 | 1296 (1226, 1334) | 381 (310, 419) | 90.6 (73.7, 99.6) | 29.4 (23.3, 35.7) |
| Pennsylvania | PA | 5556 | 5933 (5774, 6016) | -377 (-535, -294) | -29.1 (-41.2, -22.7) | -6.4 (-8.8, -3.9) |
| South Carolina | SC | 2636 | 2518 (2419, 2570) | 118 (19, 171) | 23.2 (3.7, 33.7) | 4.7 (0.7, 8.7) |
| Tennessee | TN | 3816 | 3836 (3701, 3907) | -20 (-155, 51) | -2.9 (-22.6, 7.4) | -0.5 (-3.7, 2.7) |
| Texas | TX | 16549 | 13789 (13531, 13922) | 2760 (2502, 2894) | 95.6 (86.7, 100.3) | 20.0 (18.2, 21.9) |
| Virginia | VA | 3537 | 3283 (3170, 3342) | 254 (142, 313) | 29.6 (16.5, 36.5) | 7.7 (4.2, 11.3) |
| Washington | WA | 2727 | 2570 (2471, 2623) | 157 (58, 210) | 20.6 (7.6, 27.6) | 6.1 (2.2, 10.1) |
| West Virginia | WV | 888 | 909 (850, 941) | -21 (-80, 11) | -11.7 (-44.4, 6.1) | -2.3 (-8.6, 4.2) |
| Wisconsin | WI | 1864 | 1843 (1759, 1888) | 21 (-63, 66) | 3.6 (-10.7, 11.2) | 1.1 (-3.4, 5.8) |

Abbreviation: CI, confidence interval

Note: Hepatic fibrosis/cirrhosis was the contributing causes of death.

a Excess death number estimated by subtract the expected number from the observed number of death.

b Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

c Excess risk was calculated as the ratio of the excess-to-expected number of death.

# Additional Table 13. The estimated excess mortality of hepatic failure by state from March 2020 to September 2022.

| **State** | **Abbreviation** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) a** | **Excess mortality**  **(95% CI) b** | **Excess risk % (95% CI) c** |
| --- | --- | --- | --- | --- | --- | --- |
| Alabama | AL | 1211 | 1075 (1011, 1110) | 136 (72, 171) | 27.2 (14.4, 34.2) | 12.7 (6.4, 19.1) |
| Arkansas | AR | 267 | 155 (131, 170) | 112 (87, 126) | 37.3 (28.9, 41.9) | 72.3 (52.2, 93.5) |
| Arizona | AZ | 1716 | 1357 (1285, 1396) | 359 (287, 398) | 50.7 (40.5, 56.2) | 26.5 (20.5, 32.5) |
| California | CA | 8347 | 7648 (7474, 7738) | 699 (525, 789) | 17.7 (13.3, 20.0) | 9.1 (6.8, 11.5) |
| Colorado | CO | 1042 | 881 (822, 912) | 161 (103, 193) | 28.1 (18.0, 33.7) | 18.3 (11.2, 25.6) |
| Connecticut | CT | 119 | 137 (114, 151) | -18 (-41, -4) | -5.0 (-11.4, -1.1) | -13.1 (-28.0, 3.2) |
| Florida | FL | 4560 | 4293 (4158, 4363) | 267 (133, 338) | 12.5 (6.2, 15.8) | 6.2 (3.2, 9.3) |
| Georgia | GA | 2487 | 2721 (2619, 2775) | -234 (-337, -180) | -22.0 (-31.7, -16.9) | -8.6 (-12.2, -5.0) |
| Illinois | IL | 2312 | 2045 (1956, 2092) | 267 (179, 315) | 20.8 (14.0, 24.6) | 13.1 (8.5, 17.7) |
| Indiana | IN | 1577 | 1674 (1594, 1717) | -97 (-177, -54) | -14.4 (-26.2, -8.0) | -5.8 (-10.4, -1.1) |
| Kansas | KS | 214 | 230 (200, 247) | -16 (-46, 1) | -5.5 (-15.7, 0.3) | -7.0 (-19.0, 5.9) |
| Kentucky | KY | 994 | 871 (813, 902) | 123 (66, 155) | 27.4 (14.7, 34.5) | 14.1 (7.1, 21.3) |
| Louisiana | LA | 460 | 446 (405, 469) | 14 (-28, 37) | 3.0 (-6.0, 7.9) | 3.1 (-6.1, 12.8) |
| Massachusetts | MA | 1432 | 1353 (1281, 1392) | 79 (7, 118) | 11.3 (1.0, 16.9) | 5.8 (0.4, 11.4) |
| Maryland | MD | 1025 | 1009 (946, 1042) | 16 (-46, 50) | 2.6 (-7.5, 8.1) | 1.6 (-4.5, 7.9) |
| Michigan | MI | 2306 | 2604 (2504, 2657) | -298 (-398, -245) | -29.6 (-39.6, -24.3) | -11.4 (-15.0, -7.8) |
| Minnesota | MN | 791 | 948 (887, 980) | -157 (-217, -124) | -27.7 (-38.3, -21.9) | -16.6 (-22.3, -10.6) |
| Missouri | MO | 1238 | 1123 (1058, 1159) | 115 (49, 150) | 18.7 (8.0, 24.4) | 10.2 (4.2, 16.5) |
| North Carolina | NC | 2718 | 2289 (2195, 2339) | 429 (335, 479) | 41.4 (32.3, 46.2) | 18.7 (14.3, 23.2) |
| New Jersey | NJ | 1865 | 1759 (1677, 1803) | 106 (24, 150) | 11.5 (2.6, 16.2) | 6.0 (1.3, 10.9) |
| New York | NY | 3594 | 3859 (3729, 3927) | -265 (-395, -197) | -13.2 (-19.6, -9.8) | -6.9 (-9.9, -3.8) |
| Ohio | OH | 2659 | 2435 (2339, 2487) | 224 (127, 275) | 19.0 (10.8, 23.4) | 9.2 (5.1, 13.4) |
| Oklahoma | OK | 130 | 90 (71, 101) | 40 (22, 52) | 10.1 (5.6, 13.2) | 44.4 (20.7, 70.3) |
| Oregon | OR | 841 | 902 (843, 934) | -61 (-119, -29) | -14.5 (-28.3, -6.9) | -6.8 (-13.0, -0.4) |
| Pennsylvania | PA | 3245 | 2999 (2891, 3055) | 246 (139, 303) | 19.0 (10.7, 23.4) | 8.2 (4.5, 12.0) |
| South Carolina | SC | 1766 | 1844 (1760, 1889) | -78 (-162, -33) | -15.4 (-31.9, -6.5) | -4.2 (-8.6, 0.3) |
| Tennessee | TN | 2014 | 1964 (1878, 2011) | 50 (-37, 96) | 7.3 (-5.4, 14.0) | 2.5 (-1.9, 7.1) |
| Texas | TX | 6991 | 6399 (6242, 6481) | 592 (435, 674) | 20.5 (15.1, 23.4) | 9.3 (6.7, 11.8) |
| Utah | UT | 67 | 80 (63, 91) | -13 (-31, -2) | -4.0 (-9.6, -0.6) | -16.2 (-35.1, 5.0) |
| Virginia | VA | 1721 | 1427 (1353, 1467) | 294 (220, 334) | 34.3 (25.6, 38.9) | 20.6 (15.0, 26.4) |
| Washington | WA | 1953 | 1998 (1910, 2044) | -45 (-132, 2) | -5.9 (-17.3, 0.3) | -2.3 (-6.5, 2.1) |
| Wisconsin | WI | 1014 | 965 (904, 998) | 49 (-12, 82) | 8.3 (-2.0, 14.0) | 5.1 (-1.3, 11.6) |

Abbreviation: CI, confidence interval

Note: Hepatic failure was the contributing causes of death.

a Excess death number estimated by subtract the expected number from the observed number of death.

b Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

c Excess risk was calculated as the ratio of the excess-to-expected number of death.

# Additional Table 14. Excess mortality associated with digestive system diseasesstratified by demographic factors and wave.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Group**a | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk % (95% CI) d** |
| Overall | 704701 | 624873 (622596, 626036) | 79828 (77551, 80992) | 242.1 (235.2, 245.6) | 12.8 (12.5, 13.0) |
| Age |  |  |  |  |  |
| 20-64 years | 254018 | 214323 (213276, 214859) | 39695 (38648, 40231) | 204.8 (199.4, 207.5) | 18.5 (18.1, 19.0) |
| 65-84 years | 322277 | 288553 (287190, 289251) | 33724 (32361, 34421) | 723.9 (694.6, 738.8) | 11.7 (11.3, 12.1) |
| Sex |  |  |  |  |  |
| Female | 323920 | 288931 (287574, 289625) | 34989 (33633, 35684) | 210.1 (202.0, 214.3) | 12.1 (11.7, 12.5) |
| Male | 380781 | 336123 (334768, 336817) | 44658 (43302, 45351) | 273.6 (265.3, 277.9) | 13.3 (12.9, 13.6) |
| Race/ethnicity e |  |  |  |  |  |
| NHW | 516533 | 464134 (462268, 465088) | 52399 (50533, 53353) | 267.3 (257.8, 272.2) | 11.3 (11.0, 11.6) |
| NHB | 74891 | 64032 (63478, 64317) | 10859 (10305, 11144) | 270.1 (256.4, 277.2) | 17.0 (16.1, 17.8) |
| Hispanic | 76152 | 63166 (62674, 63419) | 12986 (12493, 13239) | 213.6 (205.5, 217.7) | 20.6 (19.7, 21.4) |
| Wave f |  |  |  |  |  |
| Wave I | 66293 | 63707 (62980, 64080) | 2586 (1859, 2959) | 7.8 (5.6, 9.0) | 4.1 (3.3, 4.9) |
| Wave II | 83980 | 74388 (73603, 74791) | 9592 (8806, 9994) | 29.1 (26.7, 30.3) | 12.9 (12.1, 13.7) |
| Wave III | 204547 | 179373 (178153, 179998) | 25174 (23954, 25798) | 76.3 (72.6, 78.2) | 14.0 (13.5, 14.5) |
| Wave IV | 119227 | 100953 (100037, 101421) | 18274 (17359, 18743) | 55.4 (52.6, 56.8) | 18.1 (17.4, 18.8) |
| Wave V | 144446 | 127946 (126916, 128474) | 16500 (15470, 17028) | 50.0 (46.9, 51.6) | 12.9 (12.3, 13.5) |
| Wave VI | 86208 | 78505 (77698, 78919) | 7703 (6896, 8117) | 23.4 (20.9, 24.6) | 9.8 (9.1, 10.5) |

Abbreviations: CI, confidence interval; NHW, non-Hispanic White; NHB, non-Hispanic Black.

a The contributing cause of death was adopted. Digestive system diseases included diseases of oral cavity, salivary glands and jaws (K00-K14), diseases of esophagus, stomach and duodenum (K20-K31), diseases of appendix (K35-K38), hernia (K40-K46), noninfective enteritis and colitis (K50-K52), other diseases of intestines (K65-K67), diseases of liver (K70-K77), diseases of gallbladder, biliary tract and pancreas (K80-K87), other diseases of digestive system (K90-K93).

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

e Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

f Waves were identified according to the weekly surveillance of COVID-19 deaths in the US. Wave I was from March 2020 to June 2020, Wave II was from June 2020 to October 2020, Wave III was from October 2020 to June 2021, Wave IV was from June 2021 to November 2021, Wave V was from November 2021 to May 2022 and Wave VI was from May 2022 to September 2022.

# Additional Table 15. Excess mortality associated with digestive organ malignancies stratified by demographic factors and wave.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Group**a | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk % (95% CI) d** |
| Overall | 469511 | 468339 (466332, 469364) | 1172 (-834, 2198) | 3.6 (-2.5, 6.7) | 0.3 (0.0, 0.5) |
| Age |  |  |  |  |  |
| 20-64 years | 131534 | 132056 (131165, 132512) | -522 (-1413, -65) | -2.7 (-7.3, -0.3) | -0.4 (-0.9, 0.1) |
| 65-84 years | 262519 | 254279 (253025, 254920) | 8240 (6986, 8882) | 176.9 (150.0, 190.6) | 3.2 (2.8, 3.6) |
| Sex |  |  |  |  |  |
| Female | 196697 | 194703 (193565, 195285) | 1994 (856, 2577) | 12.0 (5.1, 15.5) | 1.0 (0.6, 1.5) |
| Male | 272814 | 273918 (272658, 274563) | -1104 (-2364, -459) | -6.8 (-14.5, -2.8) | -0.4 (-0.8, 0.0) |
| Race/ethnicity e |  |  |  |  |  |
| NHW | 339635 | 338311 (336768, 339100) | 1324 (-219, 2113) | 6.8 (-1.1, 10.8) | 0.4 (0.1, 0.7) |
| NHB | 58673 | 58704 (58170, 58979) | -31 (-565, 243) | -0.8 (-14.1, 6.0) | -0.1 (-0.9, 0.8) |
| Hispanic | 44187 | 42525 (42110, 42739) | 1662 (1246, 1876) | 27.3 (20.5, 30.9) | 3.9 (2.9, 4.9) |
| Wave f |  |  |  |  |  |
| Wave I | 47762 | 47836 (47195, 48166) | -74 (-716, 255) | -0.2 (-2.2, 0.8) | -0.2 (-1.0, 0.7) |
| Wave II | 58121 | 58162 (57455, 58525) | -41 (-749, 321) | -0.1 (-2.3, 1.0) | -0.1 (-0.9, 0.7) |
| Wave III | 133504 | 132783 (131715, 133330) | 721 (-348, 1268) | 2.2 (-1.1, 3.8) | 0.5 (0.0, 1.1) |
| Wave IV | 78025 | 77469 (76653, 77887) | 556 (-260, 975) | 1.7 (-0.8, 3.0) | 0.7 (0.0, 1.4) |
| Wave V | 92269 | 92259 (91368, 92715) | 10 (-880, 467) | 0.0 (-2.7, 1.4) | 0.0 (-0.6, 0.7) |
| Wave VI | 59830 | 59829 (59112, 60197) | 1 (-717, 369) | 0.0 (-2.2, 1.1) | 0.0 (-0.8, 0.8) |

Abbreviations: CI, confidence interval; NHW, non-Hispanic White; NHB, non-Hispanic Black.

a The contributing cause of death was adopted. Digestive organ malignancies included malignant neoplasm of esophagus (C15), stomach (C16), small intestine (C17), colon (C18), rectosigmoid junction (C19), rectum (C20), anus and anal canal (C21), liver and intrahepatic bile duct (C22), gallbladder (C23), other and unspecified parts of biliary tract (C24), pancreas (C25), and other and ill-defined digestive organs (C26).

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

e Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

f Waves were identified according to the weekly surveillance of COVID-19 deaths in the US. Wave I was from March 2020 to June 2020, Wave II was from June 2020 to October 2020, Wave III was from October 2020 to June 2021, Wave IV was from June 2021 to November 2021, Wave V was from November 2021 to May 2022 and Wave VI was from May 2022 to September 2022.

# Additional Table 16. Excess mortality associated with gastrointestinal hemorrhage stratified by demographic factors and wave.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Group** a | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) b** | **Excess mortality**  **(95% CI) c** | **Excess risk % (95% CI) d** |
| Overall | 136491 | 110004 (109239, 110397) | 26487 (25721, 26879) | 80.3 (78.0, 81.5) | 24.1 (23.4, 24.7) |
| Age |  |  |  |  |  |
| 20-64 years | 37951 | 27602 (27153, 27834) | 10349 (9899, 10580) | 53.4 (51.1, 54.6) | 37.5 (36.1, 38.9) |
| 65-84 years | 59531 | 47681 (47206, 47925) | 11850 (11375, 12094) | 254.4 (244.2, 259.6) | 24.9 (23.9, 25.9) |
| Sex |  |  |  |  |  |
| Female | 58755 | 47363 (46863, 47620) | 11392 (10892, 11649) | 68.4 (65.4, 70.0) | 24.1 (23.1, 25.1) |
| Male | 77736 | 62699 (62114, 63000) | 15037 (14452, 15337) | 92.1 (88.6, 94.0) | 24.0 (23.1, 24.9) |
| Race/ethnicity e |  |  |  |  |  |
| NHW | 98692 | 81694 (81036, 82031) | 16998 (16340, 17336) | 86.7 (83.4, 88.4) | 20.8 (20.1, 21.6) |
| NHB | 15390 | 11863 (11626, 11987) | 3527 (3289, 3650) | 87.7 (81.8, 90.8) | 29.7 (27.7, 31.8) |
| Hispanic | 13853 | 9537 (9324, 9647) | 4316 (4103, 4427) | 71.0 (67.5, 72.8) | 45.3 (42.8, 47.7) |
| Wave f |  |  |  |  |  |
| Wave I | 12863 | 11583 (11334, 11711) | 1280 (1032, 1409) | 3.9 (3.1, 4.3) | 11.1 (9.1, 13.0) |
| Wave II | 16248 | 13124 (12860, 13261) | 3124 (2859, 3261) | 9.5 (8.7, 9.9) | 23.8 (21.9, 25.7) |
| Wave III | 40665 | 32179 (31765, 32392) | 8486 (8072, 8699) | 25.7 (24.5, 26.4) | 26.4 (25.1, 27.6) |
| Wave IV | 22822 | 17431 (17127, 17589) | 5391 (5086, 5548) | 16.3 (15.4, 16.8) | 30.9 (29.2, 32.6) |
| Wave V | 28062 | 22469 (22123, 22647) | 5593 (5247, 5772) | 17.0 (15.9, 17.5) | 24.9 (23.4, 26.4) |
| Wave VI | 15831 | 13218 (12953, 13356) | 2613 (2347, 2750) | 7.9 (7.1, 8.3) | 19.8 (17.9, 21.6) |

Abbreviations: CI, confidence interval; NHW, non-Hispanic White; NHB, non-Hispanic Black.

a The contributing cause of death was adopted. Gastrointestinal hemorrhage included esophageal varices with bleeding (I85.0); gastro-esophageal laceration-hemorrhage syndrome (K22.6); hemorrhage of esophagus, NOS (K22.8); gastric ulcer with acute bleeding (K25.0), acute bleeding and perforation (K25.2), chronic or unspecified bleeding (K25.4), chronic or unspecified bleeding and perforation (K25.6); and duodenal ulcers (K26.0, K26.2, K26.4, and K26.6), gastric ulcer at unspecified site (K27.0, K27.2, K27.4, and K27.6), and gastrojejunostomy ulcer (K28.0, K28.2, K28.4, and K28.6) as classified above; acute (corrosive) gastritis with bleeding (K29.0); anus and rectum bleeding (K62.5) and GI bleeding, NOS (K92.2).

b Excess death number estimated by subtract the expected number from the observed number of death.

c Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

d Excess risk was calculated as the ratio of the excess-to-expected number of death.

e Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

f Waves were identified according to the weekly surveillance of COVID-19 deaths in the US. Wave I was from March 2020 to June 2020, Wave II was from June 2020 to October 2020, Wave III was from October 2020 to June 2021, Wave IV was from June 2021 to November 2021, Wave V was from November 2021 to May 2022 and Wave VI was from May 2022 to September 2022.

# Additional Table 17. Sensitivity analysis of excess mortality associated with digestive related diseases from March 2020 to September 2022.a

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cause of death b** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) c** | **Excess mortality**  **(95% CI) d** | **Excess risk % (95% CI) e** |
| **GI diseases** | | | | | |
| GI hemorrhage, NOS | 111669 | 91855 (91202, 92190) | 19814 (19161, 20149) | 59.7 (57.7, 60.7) | 21.6 (20.9, 22.3) |
| Ulcers | 21310 | 18935 (18644, 19086) | 2375 (2083, 2525) | 7.2 (6.3, 7.6) | 12.5 (11.0, 14.1) |
| Paralytic and intestinal obstruction | 51971 | 50007 (49519, 50258) | 1964 (1476, 2215) | 5.9 (4.4, 6.7) | 3.9 (3.0, 4.8) |
| Intestine vascular disorder | 41516 | 42808 (42344, 43047) | -1292 (-1757, -1054) | -3.9 (-5.3, -3.2) | -3.0 (-3.9, -2.1) |
| *C. difficile* colitis | 20533 | 16050 (15802, 16179) | 4483 (4234, 4611) | 13.5 (12.8, 13.9) | 27.9 (26.2, 29.7) |
| EC | 45080 | 48828 (48395, 49051) | -3748 (-4181, -3525) | -11.3 (-12.6, -10.6) | -7.7 (-8.5, -6.8) |
| GC | 31249 | 31772 (31423, 31952) | -523 (-872, -343) | -1.6 (-2.6, -1.0) | -1.6 (-2.7, -0.6) |
| CRC | 162973 | 158284 (157461, 158705) | 4689 (3867, 5111) | 14.1 (11.7, 15.4) | 3.0 (2.5, 3.5) |
| **Liver and pancreatic diseases** | | | | | |
| ALD | 105612 | 88713 (88129, 89012) | 16899 (16316, 17199) | 50.9 (49.2, 51.8) | 19.0 (18.3, 19.8) |
| Fibrosis/cirrhosis | 136997 | 128566 (127849, 128933) | 8431 (7715, 8799) | 25.4 (23.2, 26.5) | 6.6 (6.0, 7.1) |
| Chronic hepatitis C | 35540 | 31445 (31097, 31624) | 4095 (3747, 4274) | 12.3 (11.3, 12.9) | 13.0 (11.9, 14.2) |
| Hepatic failure | 79265 | 74938 (74398, 75216) | 4327 (3787, 4604) | 13.0 (11.4, 13.9) | 5.8 (5.0, 6.5) |
| LIHC | 82556 | 81132 (80573, 81418) | 1424 (866, 1711) | 4.3 (2.6, 5.2) | 1.8 (1.1, 2.5) |
| AP | 18297 | 15188 (14935, 15319) | 3109 (2856, 3240) | 9.4 (8.6, 9.8) | 20.5 (18.7, 22.2) |
| PC | 129727 | 130159 (129416, 130540) | -432 (-1175, -51) | -1.3 (-3.5, -0.2) | -0.3 (-0.9, 0.2) |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; EC, esophageal cancer; GC, gastric cancer; CRC, colorectal cancer; ALD, alcohol liver disease; LIHC, liver and intrahepatic cancer; AP, acute pancreatitis; PC, pancreatic cancer.

a Sensitivity analysis was conducted by removing January 2018 and February 2018.

b The contributing cause of death was adopted.

c Excess death number estimated by subtract the expected number from the observed number of death.

d Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

e Excess risk was calculated as the ratio of the excess-to-expected number of death.

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# Additional Table 18. Sensitivity analysis of excess mortality associated with digestive related diseases from March 2020 to September 2022.a

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cause of death b** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) c** | **Excess mortality**  **(95% CI) d** | **Excess risk % (95% CI) e** |
| **GI diseases** | | | | | |
| GI hemorrhage, NOS | 111669 | 90060 (89410, 90393) | 21609 (20959, 21943) | 65.1 (63.1, 66.1) | 24.0 (23.3, 24.7) |
| Ulcers | 21310 | 18327 (18058, 18466) | 2983 (2715, 3122) | 9.0 (8.2, 9.4) | 16.3 (14.7, 17.8) |
| Paralytic ileus and intestine obstruction | 51971 | 51155 (50673, 51403) | 816 (333, 1064) | 2.5 (1.0, 3.2) | 1.6 (0.7, 2.5) |
| Vascular disorder of intestine | 41516 | 42394 (41933, 42632) | -878 (-1340, -641) | -2.6 (-4.0, -1.9) | -2.1 (-3.0, -1.1) |
| *C. difficile* colitis | 20533 | 15148 (14906, 15273) | 5385 (5143, 5510) | 16.2 (15.5, 16.6) | 35.5 (33.7, 37.4) |
| EC | 45080 | 47515 (47069, 47745) | -2435 (-2881, -2205) | -7.3 (-8.7, -6.6) | -5.1 (-6.0, -4.2) |
| GC | 31249 | 31903 (31553, 32084) | -654 (-1004, -474) | -2.0 (-3.0, -1.4) | -2.0 (-3.1, -1.0) |
| CRC | 162973 | 158037 (157153, 158490) | 4936 (4051, 5389) | 14.9 (12.2, 16.2) | 3.1 (2.6, 3.6) |
| **Liver and pancreatic diseases** | | | | | |
| ALD | 105612 | 88367 (87779, 88669) | 17245 (16657, 17547) | 52.0 (50.2, 52.9) | 19.5 (18.8, 20.2) |
| Fibrosis/cirrhosis | 136997 | 126465 (125632, 126892) | 10532 (9700, 10959) | 31.7 (29.2, 33.0) | 8.3 (7.8, 8.9) |
| Chronic hepatitis C | 35540 | 30956 (30590, 31145) | 4584 (4217, 4773) | 13.8 (12.7, 14.4) | 14.8 (13.6, 16.0) |
| Hepatic failure | 79265 | 74100 (73505, 74405) | 5165 (4570, 5471) | 15.6 (13.8, 16.5) | 7.0 (6.2, 7.7) |
| LIHC | 82556 | 82244 (81599, 82575) | 312 (-333, 643) | 0.9 (-1.0, 1.9) | 0.4 (-0.3, 1.1) |
| AP | 18297 | 15201 (14941, 15335) | 3096 (2836, 3231) | 9.3 (8.5, 9.7) | 20.4 (18.6, 22.1) |
| PC | 129727 | 132602 (131774, 133027) | -2875 (-3704, -2451) | -8.7 (-11.2, -7.4) | -2.2 (-2.7, -1.6) |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; EC, esophageal cancer; GC, gastric cancer; CRC, colorectal cancer; ALD, alcohol liver disease; LIHC, liver and intrahepatic cancer; AP, acute pancreatitis; PC, pancreatic cancer.

a Sensitivity analysis was conducted with harmonics = 8.

b The contributing cause of death was adopted.

c Excess death number estimated by subtract the expected number from the observed number of death.

d Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

e Excess risk was calculated as the ratio of the excess-to-expected number of death.

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# Additional Table 19. Sensitivity analysis of excess mortality associated with selected gastrointestinal diseases stratified by demographic factor and pandemic wave. a

| **Cause of death b** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) c** | **Excess mortality**  **(95% CI) d** | **Excess risk % (95% CI) e** |
| --- | --- | --- | --- | --- | --- |
| **GI hemorrhage, NOS** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 29214 | 21699 (21358, 21875) | 7515 (7173, 7691) | 38.8 (37.0, 39.7) | 34.6 (33.1, 36.2) |
| 65-84 years | 51555 | 41792 (41387, 42000) | 9763 (9358, 9972) | 209.6 (200.9, 214.0) | 23.4 (22.3, 24.4) |
| Sex |  |  |  |  |  |
| Female | 49701 | 40816 (40390, 41035) | 8885 (8459, 9104) | 53.4 (50.8, 54.7) | 21.8 (20.7, 22.8) |
| Male | 61968 | 50678 (50158, 50945) | 11290 (10770, 11557) | 69.2 (66.0, 70.8) | 22.3 (21.3, 23.2) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 81314 | 68556 (67963, 68860) | 12758 (12166, 13062) | 65.1 (62.1, 66.6) | 18.6 (17.8, 19.4) |
| NHB | 13875 | 11073 (10839, 11194) | 2802 (2568, 2924) | 69.7 (63.9, 72.7) | 25.3 (23.2, 27.4) |
| Hispanic | 10322 | 6891 (6728, 6976) | 3431 (3269, 3516) | 56.4 (53.8, 57.8) | 49.8 (46.9, 52.7) |
| Wave g |  |  |  |  |  |
| Wave I | 10532 | 9612 (9400, 9721) | 920 (709, 1030) | 2.8 (2.1, 3.1) | 9.6 (7.5, 11.7) |
| Wave II | 13288 | 10842 (10618, 10959) | 2446 (2221, 2562) | 7.4 (6.7, 7.7) | 22.6 (20.5, 24.7) |
| Wave III | 33477 | 26748 (26396, 26930) | 6729 (6376, 6911) | 20.3 (19.2, 20.8) | 25.2 (23.8, 26.5) |
| Wave IV | 18776 | 14597 (14337, 14732) | 4179 (3918, 4314) | 12.6 (11.8, 13.0) | 28.6 (26.8, 30.5) |
| Wave V | 22879 | 18884 (18587, 19037) | 3995 (3699, 4148) | 12.0 (11.1, 12.5) | 21.2 (19.6, 22.7) |
| Wave VI | 12717 | 11172 (10945, 11291) | 1545 (1317, 1663) | 4.7 (4.0, 5.0) | 13.8 (11.9, 15.8) |
| **Ulcers** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 3156 | 2444 (2285, 2527) | 712 (554, 796) | 3.7 (2.9, 4.1) | 29.1 (24.7, 33.7) |
| 65-84 years | 10705 | 10678 (10357, 10844) | 27 (-294, 192) | 0.6 (-6.3, 4.1) | 0.3 (-1.6, 2.2) |
| Sex |  |  |  |  |  |
| Female | 9976 | 8754 (8561, 8855) | 1222 (1028, 1322) | 7.3 (6.2, 7.9) | 14.0 (11.7, 16.2) |
| Male | 11334 | 10102 (9889, 10212) | 1232 (1019, 1343) | 7.5 (6.2, 8.2) | 12.2 (10.1, 14.3) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 15851 | 14522 (14286, 14644) | 1329 (1093, 1452) | 6.8 (5.6, 7.4) | 9.2 (7.5, 10.9) |
| NHB | 2216 | 1756 (1674, 1800) | 460 (378, 504) | 11.4 (9.4, 12.5) | 26.2 (21.0, 31.5) |
| Hispanic | 1676 | 1485 (1409, 1525) | 191 (116, 232) | 3.1 (1.9, 3.8) | 12.9 (7.5, 18.3) |
| Wave g |  |  |  |  |  |
| Wave I | 2059 | 1992 (1897, 2042) | 67 (-27, 117) | 0.2 (-0.1, 0.4) | 3.4 (-1.1, 7.9) |
| Wave II | 2478 | 2108 (2010, 2159) | 370 (273, 422) | 1.1 (0.8, 1.3) | 17.6 (13.0, 22.2) |
| Wave III | 6201 | 5569 (5412, 5652) | 632 (474, 714) | 1.9 (1.4, 2.2) | 11.3 (8.6, 14.1) |
| Wave IV | 3559 | 2952 (2837, 3013) | 607 (492, 668) | 1.8 (1.5, 2.0) | 20.6 (16.6, 24.6) |
| Wave V | 4481 | 4048 (3913, 4118) | 433 (299, 504) | 1.3 (0.9, 1.5) | 10.7 (7.5, 14.0) |
| Wave VI | 2532 | 2267 (2166, 2320) | 265 (165, 319) | 0.8 (0.5, 1.0) | 11.7 (7.4, 16.1) |
| ***C. difficile* colitis** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 1250 | 861 (793, 898) | 389 (321, 425) | 2.0 (1.7, 2.2) | 45.2 (37.2, 53.3) |
| 65-84 years | 11177 | 8341 (8141, 8444) | 2836 (2637, 2940) | 60.9 (56.6, 63.1) | 34.0 (31.5, 36.5) |
| Sex |  |  |  |  |  |
| Female | 11111 | 8505 (8324, 8599) | 2606 (2426, 2701) | 15.6 (14.6, 16.2) | 30.6 (28.2, 33.1) |
| Male | 9422 | 7520 (7350, 7609) | 1902 (1732, 1991) | 11.7 (10.6, 12.2) | 25.3 (22.8, 27.8) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 15999 | 12423 (12205, 12537) | 3576 (3357, 3689) | 18.2 (17.1, 18.8) | 28.8 (26.8, 30.8) |
| NHB | 2081 | 1459 (1384, 1499) | 622 (547, 662) | 15.5 (13.6, 16.5) | 42.6 (36.6, 48.8) |
| Hispanic | 1283 | 1406 (1332, 1445) | -123 (-196, -83) | -2.0 (-3.2, -1.4) | -8.7 (-13.7, -3.7) |
| Wave g |  |  |  |  |  |
| Wave I | 2105 | 2074 (1985, 2122) | 31 (-59, 78) | 0.1 (-0.2, 0.2) | 1.5 (-2.8, 5.9) |
| Wave II | 2349 | 2094 (2004, 2141) | 255 (166, 303) | 0.8 (0.5, 0.9) | 12.2 (7.7, 16.8) |
| Wave III | 5856 | 4885 (4748, 4957) | 971 (834, 1043) | 2.9 (2.5, 3.1) | 19.9 (16.8, 23.0) |
| Wave IV | 3436 | 2361 (2266, 2411) | 1075 (980, 1126) | 3.2 (3.0, 3.4) | 45.5 (40.7, 50.4) |
| Wave V | 4277 | 3014 (2907, 3071) | 1263 (1155, 1319) | 3.8 (3.5, 4.0) | 41.9 (37.7, 46.2) |
| Wave VI | 2510 | 1622 (1543, 1664) | 888 (809, 930) | 2.7 (2.4, 2.8) | 54.7 (48.8, 60.9) |
| **CRC** | - | - | - | - | - |
| Age |  |  |  |  |  |
| 20-64 years | 47489 | 45910 (45430, 46157) | 1579 (1099, 1826) | 8.1 (5.7, 9.4) | 3.4 (2.5, 4.4) |
| 65-84 years | 80438 | 74349 (73795, 74634) | 6089 (5534, 6374) | 130.7 (118.8, 136.8) | 8.2 (7.4, 8.9) |
| Sex |  |  |  |  |  |
| Female | 75149 | 73617 (73020, 73923) | 1532 (936, 1839) | 9.2 (5.6, 11.0) | 2.1 (1.4, 2.8) |
| Male | 87824 | 84012 (83444, 84304) | 3812 (3244, 4104) | 23.4 (19.9, 25.1) | 4.5 (3.8, 5.2) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 119910 | 115349 (114639, 115714) | 4561 (3850, 4925) | 23.3 (19.6, 25.1) | 4.0 (3.4, 4.5) |
| NHB | 21136 | 20725 (20443, 20871) | 411 (129, 557) | 10.2 (3.2, 13.9) | 2.0 (0.6, 3.4) |
| Hispanic | 13527 | 12722 (12481, 12847) | 805 (564, 930) | 13.2 (9.3, 15.3) | 6.3 (4.5, 8.1) |
| Wave g |  |  |  |  |  |
| Wave I | 16586 | 16296 (16032, 16433) | 290 (26, 426) | 0.9 (0.1, 1.3) | 1.8 (0.2, 3.3) |
| Wave II | 20033 | 19757 (19466, 19907) | 276 (-14, 427) | 0.8 (0.0, 1.3) | 1.4 (0.0, 2.8) |
| Wave III | 46842 | 45190 (44751, 45416) | 1652 (1212, 1878) | 5.0 (3.7, 5.7) | 3.7 (2.7, 4.6) |
| Wave IV | 27015 | 26089 (25756, 26262) | 926 (592, 1098) | 2.8 (1.8, 3.3) | 3.5 (2.3, 4.8) |
| Wave V | 32039 | 31042 (30678, 31230) | 997 (633, 1185) | 3.0 (1.9, 3.6) | 3.2 (2.1, 4.3) |
| Wave VI | 20458 | 19909 (19618, 20060) | 549 (257, 700) | 1.7 (0.8, 2.1) | 2.8 (1.4, 4.2) |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; CRC, colorectal cancer; NHW, non-Hispanic White inhabitants; NHB, non-Hispanic Black inhabitants.

a Sensitivity analysis was conducted by removing January 2018 and February 2018.

b The contributing cause of death was adopted.

c Excess death number estimated by subtract the expected number from the observed number of death.

d Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

e Excess risk was calculated as the ratio of the excess-to-expected number of death.

f Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

g Waves were identified according to the weekly surveillance of COVID-19 deaths in the US. Wave I was from March 2020 to June 2020, Wave II was from June 2020 to October 2020, Wave III was from October 2020 to June 2021, Wave IV was from June 2021 to November 2021, Wave V was from November 2021 to May 2022 and Wave VI was from May 2022 to September 2022.

# Additional Table 20. Sensitivity analysis of excess mortality associated with selected liver and pancreatic diseases stratified by demographic factor and pandemic wave. a

| **Cause of death b** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) c** | **Excess mortality**  **(95% CI) d** | **Excess risk % (95% CI) e** |
| --- | --- | --- | --- | --- | --- |
| **ALD** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 76511 | 62786 (62278, 63047) | 13725 (13217, 13986) | 70.8 (68.2, 72.2) | 21.9 (21.0, 22.7) |
| 65-84 years | 27348 | 23444 (23121, 23611) | 3904 (3581, 4070) | 83.8 (76.9, 87.4) | 16.7 (15.3, 18.0) |
| Sex |  |  |  |  |  |
| Female | 32163 | 26975 (26653, 27141) | 5188 (4866, 5354) | 31.2 (29.2, 32.2) | 19.2 (17.9, 20.5) |
| Male | 73449 | 61502 (61016, 61752) | 11947 (11461, 12197) | 73.2 (70.2, 74.7) | 19.4 (18.6, 20.3) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 72923 | 62543 (62052, 62795) | 10380 (9890, 10632) | 53.0 (50.5, 54.2) | 16.6 (15.8, 17.4) |
| NHB | 8472 | 6621 (6457, 6707) | 1851 (1687, 1936) | 46.0 (42.0, 48.2) | 28.0 (25.2, 30.7) |
| Hispanic | 16669 | 13924 (13683, 14048) | 2745 (2505, 2870) | 45.1 (41.2, 47.2) | 19.7 (17.9, 21.5) |
| Wave g |  |  |  |  |  |
| Wave I | 9457 | 8684 (8501, 8779) | 773 (591, 868) | 2.3 (1.8, 2.6) | 8.9 (6.7, 11.1) |
| Wave II | 13166 | 10621 (10419, 10726) | 2545 (2343, 2650) | 7.7 (7.1, 8.0) | 24.0 (21.9, 26.1) |
| Wave III | 31286 | 25085 (24775, 25246) | 6201 (5890, 6361) | 18.7 (17.7, 19.2) | 24.7 (23.3, 26.1) |
| Wave IV | 18434 | 14682 (14444, 14805) | 3752 (3515, 3876) | 11.3 (10.6, 11.7) | 25.6 (23.7, 27.4) |
| Wave V | 20945 | 18019 (17756, 18155) | 2926 (2663, 3062) | 8.8 (8.0, 9.2) | 16.2 (14.7, 17.8) |
| Wave VI | 12324 | 11622 (11410, 11731) | 702 (491, 812) | 2.1 (1.5, 2.4) | 6.0 (4.2, 7.9) |
| **Chronic hepatitis C** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 16749 | 14950 (14701, 15079) | 1799 (1551, 1928) | 9.3 (8.0, 9.9) | 12.0 (10.3, 13.7) |
| 65-84 years | 14793 | 12912 (12673, 13036) | 1881 (1642, 2005) | 40.4 (35.2, 43.0) | 14.6 (12.7, 16.4) |
| Sex |  |  |  |  |  |
| Female | 10436 | 9092 (8905, 9189) | 1344 (1157, 1441) | 8.1 (6.9, 8.7) | 14.8 (12.6, 17.0) |
| Male | 25104 | 22270 (21977, 22421) | 2834 (2542, 2986) | 17.4 (15.6, 18.3) | 12.7 (11.3, 14.1) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 22453 | 20147 (19869, 20291) | 2306 (2028, 2450) | 11.8 (10.3, 12.5) | 11.4 (10.0, 12.9) |
| NHB | 6393 | 5420 (5276, 5496) | 973 (828, 1048) | 24.2 (20.6, 26.1) | 18.0 (15.1, 20.9) |
| Hispanic | 4488 | 3588 (3468, 3651) | 900 (780, 963) | 14.8 (12.8, 15.8) | 25.1 (21.5, 28.8) |
| Wave g |  |  |  |  |  |
| Wave I | 4065 | 3644 (3526, 3707) | 421 (302, 483) | 1.3 (0.9, 1.5) | 11.6 (8.2, 15.0) |
| Wave II | 4731 | 4083 (3958, 4149) | 648 (522, 714) | 2.0 (1.6, 2.2) | 15.9 (12.6, 19.2) |
| Wave III | 10560 | 9344 (9154, 9442) | 1216 (1027, 1315) | 3.7 (3.1, 4.0) | 13.0 (10.9, 15.2) |
| Wave IV | 5715 | 4941 (4804, 5014) | 774 (636, 846) | 2.3 (1.9, 2.5) | 15.7 (12.7, 18.7) |
| Wave V | 6708 | 5935 (5784, 6014) | 773 (622, 852) | 2.3 (1.9, 2.6) | 13.0 (10.3, 15.7) |
| Wave VI | 3761 | 3497 (3381, 3558) | 264 (148, 325) | 0.8 (0.4, 1.0) | 7.5 (4.1, 11.0) |
| **Fibrosis/cirrhosis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 55791 | 49329 (48813, 49595) | 6462 (5945, 6727) | 33.3 (30.7, 34.7) | 13.1 (12.2, 14.0) |
| 65-84 years | 70205 | 66419 (65914, 66678) | 3786 (3281, 4046) | 81.3 (70.4, 86.8) | 5.7 (4.9, 6.5) |
| Sex |  |  |  |  |  |
| Female | 58190 | 54213 (53756, 54448) | 3977 (3521, 4212) | 23.9 (21.1, 25.3) | 7.3 (6.5, 8.2) |
| Male | 78807 | 73880 (73347, 74154) | 4927 (4394, 5201) | 30.2 (26.9, 31.9) | 6.7 (5.9, 7.4) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 97028 | 92410 (91815, 92716) | 4618 (4022, 4924) | 23.6 (20.5, 25.1) | 5.0 (4.3, 5.7) |
| NHB | 11965 | 11262 (11033, 11380) | 703 (475, 822) | 17.5 (11.8, 20.4) | 6.2 (4.3, 8.2) |
| Hispanic | 20576 | 17081 (16818, 17217) | 3495 (3232, 3631) | 57.5 (53.2, 59.7) | 20.5 (18.8, 22.1) |
| Wave g |  |  |  |  |  |
| Wave I | 12871 | 12718 (12492, 12835) | 153 (-72, 270) | 0.5 (-0.2, 0.8) | 1.2 (-0.5, 3.0) |
| Wave II | 16352 | 14913 (14669, 15039) | 1439 (1195, 1566) | 4.3 (3.6, 4.7) | 9.6 (8.0, 11.3) |
| Wave III | 39900 | 36594 (36212, 36791) | 3306 (2924, 3503) | 10.0 (8.8, 10.6) | 9.0 (8.0, 10.1) |
| Wave IV | 23043 | 20901 (20612, 21050) | 2142 (1854, 2292) | 6.5 (5.6, 6.9) | 10.2 (8.8, 11.7) |
| Wave V | 28129 | 26786 (26459, 26955) | 1343 (1016, 1511) | 4.0 (3.1, 4.6) | 5.0 (3.8, 6.2) |
| Wave VI | 16702 | 16654 (16397, 16788) | 48 (-210, 181) | 0.1 (-0.6, 0.5) | 0.3 (-1.2, 1.8) |
| **Hepatic failure** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 39474 | 35223 (34828, 35427) | 4251 (3855, 4455) | 21.9 (19.9, 23.0) | 12.1 (11.0, 13.2) |
| 65-84 years | 33526 | 32631 (32255, 32824) | 895 (520, 1089) | 19.2 (11.2, 23.4) | 2.7 (1.6, 3.8) |
| Sex |  |  |  |  |  |
| Female | 34853 | 32886 (32531, 33069) | 1967 (1611, 2150) | 11.8 (9.7, 12.9) | 6.0 (4.9, 7.1) |
| Male | 44412 | 41758 (41358, 41965) | 2654 (2253, 2860) | 16.3 (13.8, 17.5) | 6.4 (5.4, 7.3) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 54979 | 52202 (51754, 52432) | 2777 (2329, 3007) | 14.2 (11.9, 15.3) | 5.3 (4.4, 6.2) |
| NHB | 8881 | 8051 (7876, 8143) | 830 (654, 921) | 20.6 (16.3, 22.9) | 10.3 (8.0, 12.6) |
| Hispanic | 10343 | 9241 (9052, 9339) | 1102 (914, 1200) | 18.1 (15.0, 19.7) | 11.9 (9.8, 14.1) |
| Wave g |  |  |  |  |  |
| Wave I | 7433 | 7695 (7522, 7785) | -262 (-435, -171) | -0.8 (-1.3, -0.5) | -3.4 (-5.6, -1.2) |
| Wave II | 9599 | 8954 (8767, 9051) | 645 (458, 742) | 1.9 (1.4, 2.2) | 7.2 (5.1, 9.4) |
| Wave III | 23338 | 21487 (21198, 21637) | 1851 (1562, 2000) | 5.6 (4.7, 6.0) | 8.6 (7.2, 10.0) |
| Wave IV | 13496 | 12157 (11939, 12270) | 1339 (1121, 1452) | 4.0 (3.4, 4.4) | 11.0 (9.1, 12.9) |
| Wave V | 15832 | 15239 (14995, 15365) | 593 (349, 719) | 1.8 (1.1, 2.2) | 3.9 (2.3, 5.5) |
| Wave VI | 9567 | 9406 (9215, 9506) | 161 (-31, 260) | 0.5 (-0.1, 0.8) | 1.7 (-0.3, 3.8) |
| **Acute pancreatitis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 5174 | 3975 (3751, 4092) | 1199 (974, 1315) | 6.2 (5.0, 6.8) | 30.2 (26.6, 33.7) |
| 65-84 years | 6078 | 4079 (3815, 4216) | 1999 (1735, 2135) | 42.9 (37.2, 45.8) | 49.0 (45.3, 52.8) |
| Sex |  |  |  |  |  |
| Female | 7323 | 5887 (5725, 5972) | 1436 (1273, 1520) | 8.6 (7.6, 9.1) | 24.4 (21.6, 27.3) |
| Male | 10974 | 9257 (9041, 9370) | 1717 (1500, 1829) | 10.5 (9.2, 11.2) | 18.5 (16.3, 20.8) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 13166 | 10809 (10587, 10924) | 2357 (2135, 2472) | 12.0 (10.9, 12.6) | 21.8 (19.7, 23.9) |
| NHB | 2382 | 1913 (1827, 1959) | 469 (383, 515) | 11.7 (9.5, 12.8) | 24.5 (19.6, 29.6) |
| Hispanic | 1582 | 1723 (1641, 1766) | -141 (-222, -97) | -2.3 (-3.7, -1.6) | -8.2 (-12.7, -3.6) |
| Wave g |  |  |  |  |  |
| Wave I | 1806 | 1556 (1475, 1600) | 250 (169, 293) | 0.8 (0.5, 0.9) | 16.1 (10.8, 21.5) |
| Wave II | 2264 | 1820 (1732, 1866) | 444 (357, 491) | 1.3 (1.1, 1.5) | 24.4 (19.3, 29.6) |
| Wave III | 5365 | 4362 (4226, 4433) | 1003 (868, 1075) | 3.0 (2.6, 3.2) | 23.0 (19.7, 26.3) |
| Wave IV | 2994 | 2446 (2344, 2500) | 548 (447, 602) | 1.7 (1.3, 1.8) | 22.4 (18.1, 26.8) |
| Wave V | 3647 | 3105 (2990, 3165) | 542 (428, 603) | 1.6 (1.3, 1.8) | 17.5 (13.7, 21.3) |
| Wave VI | 2221 | 1900 (1811, 1948) | 321 (231, 368) | 1.0 (0.7, 1.1) | 16.9 (12.1, 21.8) |

Abbreviations: CI, confidence interval; ALD,alcoholic liver disease NHW, non-Hispanic White inhabitants; NHB, non-Hispanic Black inhabitants.

a Sensitivity analysis was conducted by removing January 2018 and February 2018.

b The contributing cause of death was adopted.

c Excess death number estimated by subtract the expected number from the observed number of death.

d Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

e Excess risk was calculated as the ratio of the excess-to-expected number of death.

f Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

g Waves were identified according to the weekly surveillance of COVID-19 deaths in the US. Wave I was from March 2020 to June 2020, Wave II was from June 2020 to October 2020, Wave III was from October 2020 to June 2021, Wave IV was from June 2021 to November 2021, Wave V was from November 2021 to May 2022 and Wave VI was from May 2022 to September 2022.

# Additional Table 21. Sensitivity analysis of excess mortality associated with selected gastrointestinal diseases stratified by demographic factor and pandemic wave. a

| **Cause of death b** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) c** | **Excess mortality**  **(95% CI) d** | **Excess risk % (95% CI) e** |
| --- | --- | --- | --- | --- | --- |
| **GI hemorrhage, NOS** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 29214 | 21306 (20960, 21484) | 7908 (7562, 8087) | 40.8 (39.0, 41.7) | 37.1 (35.5, 38.7) |
| 65-84 years | 51555 | 40895 (40495, 41101) | 10660 (10260, 10866) | 228.8 (220.2, 233.2) | 26.1 (25.0, 27.2) |
| Sex |  |  |  |  |  |
| Female | 49701 | 40102 (39687, 40316) | 9599 (9184, 9813) | 57.6 (55.2, 58.9) | 23.9 (22.8, 25.0) |
| Male | 61968 | 49600 (49076, 49870) | 12368 (11844, 12637) | 75.8 (72.6, 77.4) | 24.9 (24.0, 25.9) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 81314 | 67486 (66906, 67784) | 13828 (13248, 14126) | 70.5 (67.6, 72.1) | 20.5 (19.7, 21.3) |
| NHB | 13875 | 10484 (10259, 10601) | 3391 (3165, 3508) | 84.4 (78.7, 87.3) | 32.3 (30.2, 34.6) |
| Hispanic | 10322 | 6758 (6597, 6842) | 3564 (3403, 3648) | 58.6 (56.0, 60.0) | 52.7 (49.8, 55.7) |
| Wave g |  |  |  |  |  |
| Wave I | 10532 | 9512 (9301, 9622) | 1020 (809, 1129) | 3.1 (2.4, 3.4) | 10.7 (8.6, 12.8) |
| Wave II | 13288 | 10673 (10449, 10789) | 2615 (2391, 2731) | 7.9 (7.2, 8.2) | 24.5 (22.4, 26.6) |
| Wave III | 33477 | 26343 (25992, 26524) | 7134 (6783, 7315) | 21.5 (20.4, 22.0) | 27.1 (25.7, 28.4) |
| Wave IV | 18776 | 14290 (14031, 14424) | 4486 (4227, 4620) | 13.5 (12.7, 13.9) | 31.4 (29.5, 33.3) |
| Wave V | 22879 | 18424 (18130, 18576) | 4455 (4161, 4607) | 13.4 (12.5, 13.9) | 24.2 (22.6, 25.8) |
| Wave VI | 12717 | 10817 (10592, 10934) | 1900 (1675, 2017) | 5.7 (5.0, 6.1) | 17.6 (15.5, 19.6) |
| **Ulcers** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 3156 | 2539 (2377, 2624) | 617 (454, 701) | 3.2 (2.3, 3.6) | 24.3 (20.0, 28.7) |
| 65-84 years | 10705 | 9676 (9373, 9832) | 1029 (726, 1185) | 22.1 (15.6, 25.4) | 10.6 (8.5, 12.7) |
| Sex |  |  |  |  |  |
| Female | 9976 | 8890 (8704, 8988) | 1086 (899, 1183) | 6.5 (5.4, 7.1) | 12.2 (10.0, 14.4) |
| Male | 11334 | 9371 (9171, 9475) | 1963 (1763, 2067) | 12.0 (10.8, 12.7) | 20.9 (18.7, 23.2) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 15851 | 13905 (13674, 14025) | 1946 (1715, 2066) | 9.9 (8.7, 10.5) | 14.0 (12.2, 15.8) |
| NHB | 2216 | 1775 (1693, 1819) | 441 (358, 485) | 11.0 (8.9, 12.1) | 24.8 (19.7, 30.1) |
| Hispanic | 1676 | 1458 (1383, 1498) | 218 (143, 258) | 3.6 (2.4, 4.2) | 15.0 (9.5, 20.5) |
| Wave g |  |  |  |  |  |
| Wave I | 2059 | 1953 (1865, 1999) | 106 (19, 153) | 0.3 (0.1, 0.5) | 5.4 (0.9, 10.0) |
| Wave II | 2478 | 2053 (1963, 2101) | 425 (335, 473) | 1.3 (1.0, 1.4) | 20.7 (16.0, 25.5) |
| Wave III | 6201 | 5417 (5271, 5494) | 784 (638, 860) | 2.4 (1.9, 2.6) | 14.5 (11.6, 17.3) |
| Wave IV | 3559 | 2863 (2757, 2919) | 696 (590, 752) | 2.1 (1.8, 2.3) | 24.3 (20.3, 28.4) |
| Wave V | 4481 | 3897 (3773, 3962) | 584 (461, 649) | 1.8 (1.4, 2.0) | 15.0 (11.6, 18.4) |
| Wave VI | 2532 | 2145 (2053, 2193) | 387 (296, 436) | 1.2 (0.9, 1.3) | 18.0 (13.5, 22.7) |
| ***C. difficile* colitis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 1250 | 843 (774, 881) | 407 (337, 444) | 2.1 (1.7, 2.3) | 48.3 (40.2, 56.6) |
| 65-84 years | 11177 | 7977 (7770, 8085) | 3200 (2992, 3308) | 68.7 (64.2, 71.0) | 40.1 (37.5, 42.7) |
| Sex |  |  |  |  |  |
| Female | 11111 | 8014 (7838, 8105) | 3097 (2922, 3189) | 18.6 (17.5, 19.2) | 38.6 (36.1, 41.2) |
| Male | 9422 | 7123 (6957, 7209) | 2299 (2134, 2386) | 14.1 (13.1, 14.6) | 32.3 (29.6, 35.0) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 15999 | 11670 (11441, 11789) | 4329 (4100, 4448) | 22.1 (20.9, 22.7) | 37.1 (35.0, 39.2) |
| NHB | 2081 | 1389 (1316, 1428) | 692 (619, 731) | 17.2 (15.4, 18.2) | 49.8 (43.5, 56.3) |
| Hispanic | 1283 | 1302 (1231, 1340) | -19 (-90, 19) | -0.3 (-1.5, 0.3) | -1.5 (-6.8, 4.0) |
| Wave g |  |  |  |  |  |
| Wave I | 2105 | 1995 (1907, 2042) | 110 (22, 157) | 0.3 (0.1, 0.5) | 5.5 (1.1, 10.1) |
| Wave II | 2349 | 2008 (1920, 2055) | 341 (253, 388) | 1.0 (0.8, 1.2) | 17.0 (12.3, 21.8) |
| Wave III | 5856 | 4658 (4524, 4729) | 1198 (1063, 1268) | 3.6 (3.2, 3.8) | 25.7 (22.5, 29.0) |
| Wave IV | 3436 | 2203 (2111, 2252) | 1233 (1141, 1282) | 3.7 (3.4, 3.9) | 56.0 (50.8, 61.2) |
| Wave V | 4277 | 2813 (2709, 2868) | 1464 (1360, 1519) | 4.4 (4.1, 4.6) | 52.0 (47.5, 56.6) |
| Wave VI | 2510 | 1471 (1395, 1511) | 1039 (964, 1080) | 3.1 (2.9, 3.3) | 70.6 (64.0, 77.4) |
| **Colorectal cancer** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 47489 | 46704 (46199, 46963) | 785 (281, 1045) | 4.0 (1.4, 5.4) | 1.7 (0.8, 2.6) |
| 65-84 years | 80438 | 74494 (73924, 74787) | 5944 (5374, 6237) | 127.6 (115.3, 133.9) | 8.0 (7.2, 8.7) |
| Sex |  |  |  |  |  |
| Female | 75149 | 72730 (72116, 73046) | 2419 (1805, 2734) | 14.5 (10.8, 16.4) | 3.3 (2.6, 4.1) |
| Male | 87824 | 84657 (84087, 84950) | 3167 (2597, 3460) | 19.4 (15.9, 21.2) | 3.7 (3.1, 4.4) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 119910 | 115754 (115026, 116128) | 4156 (3428, 4529) | 21.2 (17.5, 23.1) | 3.6 (3.0, 4.2) |
| NHB | 21136 | 20053 (19775, 20196) | 1083 (806, 1227) | 26.9 (20.1, 30.5) | 5.4 (4.0, 6.8) |
| Hispanic | 13527 | 12850 (12597, 12981) | 677 (425, 808) | 11.1 (7.0, 13.3) | 5.3 (3.5, 7.0) |
| Wave g |  |  |  |  |  |
| Wave I | 16586 | 16272 (15988, 16419) | 314 (30, 461) | 0.9 (0.1, 1.4) | 1.9 (0.4, 3.5) |
| Wave II | 20033 | 19699 (19387, 19861) | 334 (21, 495) | 1.0 (0.1, 1.5) | 1.7 (0.3, 3.1) |
| Wave III | 46842 | 45200 (44727, 45443) | 1642 (1169, 1885) | 4.9 (3.5, 5.7) | 3.6 (2.7, 4.6) |
| Wave IV | 27015 | 26104 (25744, 26289) | 911 (552, 1097) | 2.7 (1.7, 3.3) | 3.5 (2.3, 4.7) |
| Wave V | 32039 | 30922 (30531, 31124) | 1117 (726, 1318) | 3.4 (2.2, 4.0) | 3.6 (2.5, 4.7) |
| Wave VI | 20458 | 19840 (19527, 20002) | 618 (304, 780) | 1.9 (0.9, 2.4) | 3.1 (1.7, 4.5) |

Abbreviations: CI, confidence interval; GI, gastrointestinal; NOS, not otherwise specified; *C. difficile*, *Clostridium difficile*; NHW, non-Hispanic White inhabitants; NHB, non-Hispanic Black inhabitants.

a Sensitivity analysis was conducted with harmonics = 8.

b The contributing cause of death was adopted.

c Excess death number estimated by subtract the expected number from the observed number of death.

d Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

e Excess risk was calculated as the ratio of the excess-to-expected number of death.

f Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

g Waves were identified according to the weekly surveillance of COVID-19 deaths in the US. Wave I was from March 2020 to June 2020, Wave II was from June 2020 to October 2020, Wave III was from October 2020 to June 2021, Wave IV was from June 2021 to November 2021, Wave V was from November 2021 to May 2022 and Wave VI was from May 2022 to September 2022.

# Additional Table 22. Sensitivity analysis of excess mortality associated with selected liver and pancreatic diseases stratified by demographic factor and pandemic wave. a

| **Cause of death b** | **Observed deaths, No.** | **Expected deaths,**  **No. (95% CI)** | **Excess deaths,**  **No. (95% CI) c** | **Excess mortality**  **(95% CI) d** | **Excess risk % (95% CI) e** |
| --- | --- | --- | --- | --- | --- |
| **Alcoholic liver disease** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 76511 | 62646 (62147, 62903) | 13865 (13365, 14122) | 71.5 (68.9, 72.9) | 22.1 (21.3, 23.0) |
| 65-84 years | 27348 | 23411 (23080, 23582) | 3937 (3606, 4108) | 84.5 (77.4, 88.2) | 16.8 (15.4, 18.2) |
| Sex |  |  |  |  |  |
| Female | 32163 | 26526 (26207, 26691) | 5637 (5318, 5802) | 33.9 (31.9, 34.8) | 21.3 (19.9, 22.6) |
| Male | 73449 | 61581 (61088, 61834) | 11868 (11376, 12122) | 72.7 (69.7, 74.3) | 19.3 (18.4, 20.1) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 72923 | 62660 (62169, 62912) | 10263 (9772, 10515) | 52.4 (49.9, 53.6) | 16.4 (15.5, 17.2) |
| NHB | 8472 | 6733 (6567, 6820) | 1739 (1573, 1826) | 43.3 (39.1, 45.4) | 25.8 (23.2, 28.5) |
| Hispanic | 16669 | 13477 (13242, 13599) | 3192 (2957, 3314) | 52.5 (48.6, 54.5) | 23.7 (21.8, 25.6) |
| Wave g |  |  |  |  |  |
| Wave I | 9457 | 8665 (8481, 8761) | 792 (608, 888) | 2.4 (1.8, 2.7) | 9.1 (7.0, 11.4) |
| Wave II | 13166 | 10572 (10369, 10678) | 2594 (2390, 2700) | 7.8 (7.2, 8.1) | 24.5 (22.4, 26.7) |
| Wave III | 31286 | 25027 (24714, 25189) | 6259 (5946, 6420) | 18.9 (17.9, 19.3) | 25.0 (23.6, 26.4) |
| Wave IV | 18434 | 14655 (14416, 14779) | 3779 (3539, 3903) | 11.4 (10.7, 11.8) | 25.8 (24.0, 27.6) |
| Wave V | 20945 | 17900 (17635, 18037) | 3045 (2780, 3182) | 9.2 (8.4, 9.6) | 17.0 (15.4, 18.6) |
| Wave VI | 12324 | 11547 (11334, 11657) | 777 (564, 887) | 2.3 (1.7, 2.7) | 6.7 (4.9, 8.6) |
| **Chronic hepatitis C** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 16749 | 14785 (14525, 14920) | 1964 (1704, 2099) | 10.1 (8.8, 10.8) | 13.3 (11.6, 15.0) |
| 65-84 years | 14793 | 12670 (12394, 12812) | 2123 (1848, 2266) | 45.6 (39.7, 48.6) | 16.8 (14.9, 18.6) |
| Sex |  |  |  |  |  |
| Female | 10436 | 8479 (8298, 8573) | 1957 (1777, 2051) | 11.8 (10.7, 12.3) | 23.1 (20.7, 25.5) |
| Male | 25104 | 22397 (22104, 22549) | 2707 (2414, 2859) | 16.6 (14.8, 17.5) | 12.1 (10.7, 13.5) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 22453 | 19787 (19495, 19938) | 2666 (2374, 2817) | 13.6 (12.1, 14.4) | 13.5 (12.0, 15.0) |
| NHB | 6393 | 5413 (5269, 5488) | 980 (836, 1056) | 24.4 (20.8, 26.3) | 18.1 (15.2, 21.0) |
| Hispanic | 4488 | 3518 (3391, 3584) | 970 (844, 1037) | 16.0 (13.9, 17.1) | 27.6 (23.9, 31.3) |
| Wave g |  |  |  |  |  |
| Wave I | 4065 | 3609 (3484, 3675) | 456 (330, 521) | 1.4 (1.0, 1.6) | 12.6 (9.2, 16.1) |
| Wave II | 4731 | 4041 (3909, 4111) | 690 (557, 759) | 2.1 (1.7, 2.3) | 17.1 (13.8, 20.4) |
| Wave III | 10560 | 9222 (9022, 9326) | 1338 (1138, 1442) | 4.0 (3.4, 4.3) | 14.5 (12.3, 16.7) |
| Wave IV | 5715 | 4845 (4700, 4920) | 870 (725, 946) | 2.6 (2.2, 2.9) | 18.0 (14.9, 21.0) |
| Wave V | 6708 | 5822 (5663, 5905) | 886 (727, 969) | 2.7 (2.2, 2.9) | 15.2 (12.5, 18.0) |
| Wave VI | 3761 | 3417 (3296, 3481) | 344 (222, 408) | 1.0 (0.7, 1.2) | 10.1 (6.6, 13.6) |
| **Fibrosis/cirrhosis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 55791 | 48304 (47737, 48595) | 7487 (6920, 7778) | 38.6 (35.7, 40.1) | 15.5 (14.5, 16.5) |
| 65-84 years | 70205 | 65561 (65027, 65835) | 4644 (4111, 4919) | 99.7 (88.2, 105.6) | 7.1 (6.3, 7.9) |
| Sex |  |  |  |  |  |
| Female | 58190 | 53179 (52714, 53418) | 5011 (4546, 5250) | 30.1 (27.3, 31.5) | 9.4 (8.5, 10.3) |
| Male | 78807 | 72810 (72259, 73093) | 5997 (5446, 6280) | 36.7 (33.4, 38.5) | 8.2 (7.5, 9.0) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 97028 | 90560 (89912, 90893) | 6468 (5820, 6801) | 33.0 (29.7, 34.7) | 7.1 (6.5, 7.8) |
| NHB | 11965 | 11206 (10970, 11328) | 759 (523, 881) | 18.9 (13.0, 21.9) | 6.8 (4.9, 8.7) |
| Hispanic | 20576 | 16787 (16523, 16923) | 3789 (3526, 3926) | 62.3 (58.0, 64.6) | 22.6 (20.9, 24.3) |
| Wave g |  |  |  |  |  |
| Wave I | 12871 | 12580 (12317, 12716) | 291 (29, 427) | 0.9 (0.1, 1.3) | 2.3 (0.6, 4.1) |
| Wave II | 16352 | 14755 (14471, 14902) | 1597 (1312, 1744) | 4.8 (4.0, 5.3) | 10.8 (9.1, 12.5) |
| Wave III | 39900 | 36120 (35675, 36349) | 3780 (3335, 4009) | 11.4 (10.0, 12.1) | 10.5 (9.4, 11.6) |
| Wave IV | 23043 | 20514 (20179, 20687) | 2529 (2193, 2702) | 7.6 (6.6, 8.1) | 12.3 (10.9, 13.8) |
| Wave V | 28129 | 26260 (25880, 26455) | 1869 (1490, 2065) | 5.6 (4.5, 6.2) | 7.1 (5.9, 8.4) |
| Wave VI | 16702 | 16236 (15937, 16390) | 466 (168, 620) | 1.4 (0.5, 1.9) | 2.9 (1.3, 4.4) |
| **Hepatic failure** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 39474 | 34998 (34582, 35211) | 4476 (4061, 4690) | 23.1 (21.0, 24.2) | 12.8 (11.7, 13.9) |
| 65-84 years | 33526 | 32136 (31751, 32335) | 1390 (1005, 1588) | 29.8 (21.6, 34.1) | 4.3 (3.2, 5.4) |
| Sex |  |  |  |  |  |
| Female | 34853 | 32847 (32491, 33030) | 2006 (1651, 2190) | 12.0 (9.9, 13.2) | 6.1 (5.0, 7.2) |
| Male | 44412 | 40972 (40570, 41179) | 3440 (3038, 3647) | 21.1 (18.6, 22.3) | 8.4 (7.4, 9.4) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 54979 | 51585 (51115, 51827) | 3394 (2923, 3636) | 17.3 (14.9, 18.6) | 6.6 (5.7, 7.5) |
| NHB | 8881 | 8154 (7977, 8246) | 727 (550, 819) | 18.1 (13.7, 20.4) | 8.9 (6.7, 11.2) |
| Hispanic | 10343 | 9108 (8921, 9205) | 1235 (1048, 1332) | 20.3 (17.2, 21.9) | 13.6 (11.4, 15.8) |
| Wave g |  |  |  |  |  |
| Wave I | 7433 | 7640 (7449, 7740) | -207 (-398, -108) | -0.6 (-1.2, -0.3) | -2.7 (-4.9, -0.5) |
| Wave II | 9599 | 8874 (8668, 8981) | 725 (519, 832) | 2.2 (1.6, 2.5) | 8.2 (6.0, 10.3) |
| Wave III | 23338 | 21328 (21009, 21493) | 2010 (1691, 2175) | 6.1 (5.1, 6.6) | 9.4 (8.0, 10.8) |
| Wave IV | 13496 | 11980 (11740, 12104) | 1516 (1277, 1640) | 4.6 (3.8, 4.9) | 12.7 (10.8, 14.6) |
| Wave V | 15832 | 15026 (14758, 15165) | 806 (538, 945) | 2.4 (1.6, 2.8) | 5.4 (3.7, 7.0) |
| Wave VI | 9567 | 9252 (9042, 9361) | 315 (105, 424) | 0.9 (0.3, 1.3) | 3.4 (1.3, 5.5) |
| **Acute pancreatitis** | | | | | |
| Age |  |  |  |  |  |
| 20-64 years | 5174 | 4332 (4098, 4453) | 842 (608, 964) | 4.3 (3.1, 5.0) | 19.4 (16.2, 22.7) |
| 65-84 years | 6078 | 4321 (4037, 4468) | 1757 (1473, 1904) | 37.7 (31.6, 40.9) | 40.7 (37.1, 44.2) |
| Sex |  |  |  |  |  |
| Female | 7323 | 6037 (5870, 6124) | 1286 (1120, 1373) | 7.7 (6.7, 8.2) | 21.3 (18.5, 24.1) |
| Male | 10974 | 9112 (8898, 9223) | 1862 (1648, 1973) | 11.4 (10.1, 12.1) | 20.4 (18.2, 22.7) |
| Race/ethnicity f |  |  |  |  |  |
| NHW | 13166 | 10834 (10615, 10948) | 2332 (2112, 2446) | 11.9 (10.8, 12.5) | 21.5 (19.5, 23.6) |
| NHB | 2382 | 2024 (1936, 2071) | 358 (269, 404) | 8.9 (6.7, 10.1) | 17.7 (13.0, 22.5) |
| Hispanic | 1582 | 1693 (1613, 1736) | -111 (-192, -68) | -1.8 (-3.2, -1.1) | -6.6 (-11.1, -1.9) |
| Wave g |  |  |  |  |  |
| Wave I | 1806 | 1557 (1474, 1602) | 249 (166, 293) | 0.8 (0.5, 0.9) | 16.0 (10.7, 21.4) |
| Wave II | 2264 | 1819 (1729, 1866) | 445 (355, 493) | 1.3 (1.1, 1.5) | 24.5 (19.4, 29.6) |
| Wave III | 5365 | 4358 (4219, 4431) | 1007 (867, 1080) | 3.0 (2.6, 3.3) | 23.1 (19.8, 26.4) |
| Wave IV | 2994 | 2455 (2350, 2510) | 539 (435, 595) | 1.6 (1.3, 1.8) | 22.0 (17.6, 26.4) |
| Wave V | 3647 | 3111 (2994, 3173) | 536 (418, 597) | 1.6 (1.3, 1.8) | 17.2 (13.5, 21.1) |
| Wave VI | 2221 | 1900 (1809, 1949) | 321 (229, 369) | 1.0 (0.7, 1.1) | 16.9 (12.1, 21.8) |

Abbreviations: CI, confidence interval; NHW, non-Hispanic White inhabitants; NHB, non-Hispanic Black inhabitants.

a Sensitivity analysis was conducted with harmonics = 8.

b The contributing cause of death was adopted.

c Excess death number estimated by subtract the expected number from the observed number of death.

d Excess mortality per 1,000,000 persons was estimated via the excess death number divided by population size.

e Excess risk was calculated as the ratio of the excess-to-expected number of death.

f Non-Hispanic unknown and non-Hispanic AIAN was excluded when stratified by race/ethnicity.

g Waves were identified according to the weekly surveillance of COVID-19 deaths in the US. Wave I was from March 2020 to June 2020, Wave II was from June 2020 to October 2020, Wave III was from October 2020 to June 2021, Wave IV was from June 2021 to November 2021, Wave V was from November 2021 to May 2022 and Wave VI was from May 2022 to September 2022.

# Additional Fig 1. **Weekly estimates of excess risks (%) associated with selected** **gastrointestinal, liver, and pancreatic diseases.** This figure shows the time-series estimates of excess risk (%) associated with selected gastrointestinal, liver, and pancreatic diseases from March 2020 to September 2022. The contributing cause of death was adopted.

# Additional Fig 2. **Weekly estimates of excess deaths for A) GI hemorrhage, B) Alcoholic liver disease and C) Hepatic fibrosis/cirrhosis by demographic characteristic.** The contributing cause of death was adopted. For each subtype, panels from left to right are weekly excess death estimates by age, sex, and racial/ethnic, respectively. For age group stratification, the estimates are shown in red for inhabitants aged 20-64 years and blue for inhabitants aged 65-84 years. For sex stratification, the estimates are shown in red for females and blue for males. For race/ethnicity stratification, the estimates are shown in red for non-Hispanic White, blue for non-Hispanic Black, and purple for Hispanic inhabitants.

# Additional Fig 3. **Temporal and spatial excess risks (%) associated with colorectal cancer.**A) temporal variated excess risks stratified by region; B) temporal variated excess risks stratified by state, where the 4-week moving average was operated for each time series; C) overall estimates by states (states with negative estimated values were not shown). The contributing cause of death was adopted.

# Additional Fig 4. **Temporal and spatial excess risk (%) associated with hepatic fibrosis/cirrhosis.** A) stratification by region; B) stratification by state, where the 4-week moving average was operated for each time series; C) overall estimates by states (states with negative estimated values were not shown). The contributing cause of death was adopted.

# Additional Fig 5. **Temporal and spatial excess risks (%) associated with hepatic failure.** A) stratification by region; B) stratification by state, where the 4-week moving average was operated for each time series; C) overall estimates by states (states with negative estimated values were not shown). The contributing cause of death was adopted.