# REFERENCES

1. Shattuck L. Art. XVI-Report to the committee of the city council. Am J Med Sci 12:177–8. 1846.

2. Snow J. On the mode of communication of cholera. 2d ed. New York: The Commonwealth Fund. 1855.

3. Mason TJ, McKay FW, Hoover R, et al. Atlas of cancer mortality for U.S. counties: 1950–1969. Washington: USGPO (DHEW pub no (NIH) 75–780). 1975.

4. Blot WJ, Harrington M, Toledo A, et al. Lung cancer after employment in shipyards during World War II. N Engl J Med 299:620–4. 1978.

5. Winn DM, Blot WJ, Shy CM, et al. Snuff dipping and oral cancer among women in the southern United States. N Engl J Med 304:745–9. 1981.

6. Mason TJ, McKay FW, Hoover R, et al. Atlas of cancer mortality among U.S. nonwhites: 1950–1969. Washington: USGPO (DHEW pub no (NIH) 76–1204). 1976.

7. Mason TJ; Fraumeni JF, Jr.; Hoover R; et al. An atlas of mortality from selected diseases. Washington: USGPO (DHHS pub no (NIH) 81–2397). 1981.

8. Pickle LW, Mason TJ, Howard N, et al. Atlas of U.S. cancer mortality among whites: 1950–1980. Washington: USGPO (DHHS pub no (NIH) 87–2900). 1987.

9. Pickle LW, Mason TJ, Howard N, et al. Atlas of U.S. cancer mortality among nonwhites: 1950–1980. Washington: USGPO (DHHS pub no (NIH) 90–1582). 1990.

10. Walter SD, Birnie SE. Mapping mortality and morbidity patterns: An international comparison. Int J Epidemiol 20:678–89. 1991.

11. Pickle LW, Herrmann DJ, eds. Cognitive aspects of statistical mapping. Working paper series report no 18. Hyattsville, Maryland: National Center for Health Statistics. 1995.

12. Devine OJ, Annest JL, Kirk ML, et al. Injury mortality atlas of the United States, 1979–1987. Atlanta: Centers for Disease Control. 1991.

13. National Center for Health Statistics. Monthly vital statistics report; vol 43 nos 1–12. Hyattsville, Maryland: National Center for Health Statistics. Public Health Service. 1995.

14. National Center for Health Statistics. Vital statistics of the United States, 1990, vol II, mortality, part A. Washington: Public Health Service. 1994.

15. U.S. Bureau of the Census. April 1, 1990, age-race-modified census counts.

16. World Health Organization. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, based on the recommendations of the Ninth Revision Conference, 1975. Geneva: World Health Organization. 1977.

17. Freedman MA. Health status indicators for the year 2000. Healthy people 2000: Statistical notes 1(1). Hyattsville, Maryland: DHHS pub no (PHS) 92–1237). 1991.

18. Gittelsohn A, Royston PN. Annotated bibliography of cause-of-death validation studies, 1958–80. National Center for Health Statistics. Vital Health Stat 2(89). 1982.

19. Rosenberg HM. The nature and accuracy of cause-of-death data. Report of the Workshop on improving cause-of-death statistics. National Committee on Vital and Health Statistics. Hyattsville, Maryland: National Center for Health Statistics. 1989.

20. Harris KW, French DK. A methodological study of quality control procedures for mortality medical coding. Vital Health Stat 2(81). 1980. DHEW pub no (PHS) 79–1355. 1980.

21. National Center for Health Statistics. Vital statistics, ICD–9 ACME decision tables for classifying underlying causes of death, 1990. NCHS instruction manual; part 2c. Hyattsville, Maryland: Public Health Service. Published annually.

22. Sirken MG, Rosenberg HM, Chevarley FM, Curtin LR. The quality of cause-of-death statistics. Am J Public Health 77:137–9. 1987.

23. Israel RA, Rosenberg HM, Curtin LR. Analytical potential for multiple cause-of-death data. Am J Epidemiol 124:161–79. 1986.

24. Gittelsohn A, Senning J. Studies on the reliability of vital and health records: I. Comparison of cause of death and hospital record diagnoses. Am J Public Health 69: 680–89. 1979.

25. Percy C, Stanek E, Gloeckler L. Accuracy of cancer death certificates and its effect on cancer mortality statistics. Am J Public Health 71:242–50. 1981.

26. Kircher T, Nelson J, Burdo H. The autopsy as a measure of accuracy of the death certificate. N Engl J Med 313:1263–9. 1985.

27. Michael S, Gard S, Schurman E, Kurth D. Sensitivity of death certificate data for monitoring diabetes mortality — Diabetic eye disease follow up study, 1985–1990. Morbidity and mortality weekly report 40(43):739–41. 1991.

28. National Center for Health Statistics. Vital statistics of the United States, 1991, vol II, mortality. Washington: Public Health Service. 1995.

29. National Center for Health Statistics. Vital statistics of the United States, 1992, vol II, mortality. Washington: Public Health Service. 1996.

30. Mason TJ. The development of the series of U.S. cancer atlases: Implications for future epidemiologic research. Stat Med 14:473–9. 1995.

31. Makuc DM, Haglund B, Ingram DD, et al. Health service areas for the United States. National Center for Health Statistics. Vital Health Stat 2(112). 1991.

32. Strategic Mapping, Inc. Atlas GIS. Santa Clara, California. 1992.

33. Dent BD. Cartography: Thematic map design. 3d ed. Dubuque, Iowa: Wm. C. Brown. p 56. 1993.

34. Sirken M, Herrmann D, White AA. Cognitive aspects of designing statistical maps. Proceedings of the survey research methods section of the 1993 annual meeting of the American Statistical Association. 586–91. 1994.

35. Pickle LW, Herrmann D, Kerwin J, et al. The impact of statistical graphic design on interpretation of disease rate maps. Proceedings of the statistical graphics section of the 1993 annual meeting of the American Statistical Association. 111–6. 1994.

36. Lewandowsky S, Herrmann DJ, Behrens JT, et al. Perception of clusters in statistical maps. Appl Cog Psych 7:533–51. 1993.

37. White AA, Pickle LW, Herrmann DJ, et al. Map design preferences associated with professional discipline. Proceedings of the statistical graphics section of the 1994 annual meeting of the American Statistical Association. 54–9. 1995.

38. Maher RJ. The interpretation of statistical maps as a function of the map reader's profession. In: Pickle LW, Herrmann DJ, eds. Cognitive aspects of statistical mapping. Working paper series report no 18. Hyattsville, Maryland: National Center for Health Statistics. 249–74. 1995.

39. Lewandowsky S, Behrens JT, Pickle LW, et al. Perception of clusters in mortality maps: Representing magnitude and statistical reliability. In: Pickle LW, Herrmann DJ, eds. Cognitive aspects of statistical mapping. Working paper series report no 18. Hyattsville, Maryland: National Center for Health Statistics. 107–32. 1995.

40. Pickle LW, Herrmann DJ, Wilson BF. A legendary study of statistical map reading: The cognitive effectiveness of statistical map legends. In: Pickle LW, Herrmann DJ, eds. Cognitive aspects of statistical mapping. Working paper series report no 18. Hyattsville, Maryland: National Center for Health Statistics. 233–48. 1995.

41. Hastie R, Hammerle O, Kerwin J, et al. Human performance reading statistical maps. J Exp Psych: Applied 2:3–16. 1996.

42. Lewandowsky S, Behrens JT. Accuracy of cluster detection in mortality maps. In: Pickle

LW, Herrmann DJ, eds. Cognitive aspects of statistical mapping. Working paper series report no 18. Hyattsville, Maryland: National Center for Health Statistics. 133–48. 1995.

43. Carswell CM, Kinslow HS, Pickle LW, Herrmann DJ. Using color to represent magnitude in statistical maps: The case for double-ended scales. In: Pickle LW, Herrmann DJ, eds. Cognitive aspects of statistical mapping. Working paper series report no 18. Hyattsville, Maryland: National Center for Health Statistics. 201–28. 1995.

44. Brewer CA, MacEachren AM, Pickle LW. Evaluation of map color schemes for the NCHS mortality atlas. Proceedings of the international symposium on computer mapping in epidemiology and environmental health, Tampa, Florida. 1995. In press.

45. MacEachren AM, Brewer CA, Pickle LW. Mapping health statistics: Representing data reliability. Proceedings of the 17th international cartographic conference, Barcelona, Spain. September 3–9, 1995. Barcelona: Institut Cartographic de Catalunya. 311–9. 1995.

46. Carr D. Converting plots to tables. Technical report no 101. Center for Computational Statistics. Fairfax, Virginia: George Mason University. 1994.

47. Fleiss JL. Statistical methods for rates and proportions. 2d ed. New York: John Wiley and Sons. 1981.

48. Pickle LW, Mungiole M, Jones GK, White AA. Analysis of mapped mortality data by mixed effects models. Proceedings of the biometrics section of the 1996 annual meeting of the American Statistical Association. In press.

49. Chiang CL. Standard error of the age-adjusted death rate. Vital statistics–selected reports; vol 47 no 9. Washington: U.S. Government Printing Office. 1961.

50. Hansen KM. Headbanging: Robust smoothing in the plane. IEEE transactions on geoscience and remote sensing 29(3):369–78. 1991.

51. Kafadar K. Choosing among two-dimensional smoothers in practice. J Comp Simul 18: 419–39. 1994.

52. Mungiole M, Pickle LW, Simonson KH, White AA. Application of a weighted headbanging algorithm to mortality data maps. Proceedings of the statistical graphics section of the 1996 annual meeting of the American Statistical Association. In press.

53. National Center for Health Statistics. Health, United States, 1994. Hyattsville, Maryland: Public Health Service. 1995.

54. American Heart Association. Heart and stroke facts. 1996.

55. Gillum RF. Trends in acute myocardial infarction and coronary heart disease death in the United States. J Am Coll Cardiol 23:1273–7. 1993.

56. Pooling project research group. Relationship of blood pressure, serum cholesterol, smoking habit, relative weight and ECG abnormalities to incidence of major coronary events: Final report of the pooling project. J Chron Dis 31:201–306. 1978.

57. Gillum RF. Cardiovascular disease in the United States: Mortality, prevalence and incidence. In: Kapoor AS, Singh BN, eds. Prognosis and risk assessment in cardiovascular disease. New York: Churchill Livingstone. 49–59. 1993.

58. Anderson KM, Wilson PWF, Odell PM, Kannel WB. AHA statement: An updated coronary risk profile. Circulation 83(1):356–62. 1991.

59. Willett WC, Manson JE, Stampfer MJ, et al. Weight, weight change, and coronary heart disease in women. JAMA 273(6):461–5. 1995.

60. Ascherio A, Willett WC. New directions in dietary studies of coronary heart disease. J Nutr 125(3 supp):647S–655S. 1995.

61. Centers for Disease Control. Public health focus: Physical activity and the prevention of coronary heart disease. Morbidity and mortality weekly report 42(35):669–72. 1993.

62. Manson JE. Postmenopausal hormone therapy and atherosclerotic disease. Amer Heart J 128:1337–43. 1994.

63. Kannel WB, McGee D, Gordon T. A general cardiovascular risk profile: The Framingham study. Amer J Cardiology 38:46–51. 1976.

64. Gillum RF. Prevalence of cardiovascular and pulmonary diseases and risk factors by region and urbanization in the United States. J Natl Med Assoc 86:105–12. 1994.

65. Gillum RF. Geographic variation in sudden coronary death. Am Heart J 19(2):380–89. 1990.

66. Ingram D, Gillum RF. Regional and urbanization differentials in coronary heart disease mortality in the United States, 1968–85. J Clin Epidemiol 42(9):857–868. 1989.

67. Centers for Disease Control. Cardiovascular disease surveillance, ischemic heart disease, 1980–1989. 1993.

68. Feinleib M, Lentzner H, Collins J, et al. Regional variation in coronary heart disease mortality and morbidity. In: Higgins M, Luepker R, eds. Trends in coronary heart disease mortality. New York: Oxford University Press. 31–43. 1988.

69. Kosary CL, Ries LAG, Miller BA, et al., eds. SEER cancer statistics review, 1973–1992: Tables and graphs, National Cancer Institute. DHHS pub no (NIH) 96–2789. Washington: U.S. Government Printing Office. 1996.

70. Davis DL, Dinse GE, Hoel DG. Decreasing cardiovascular disease and increasing cancer among whites in the United States from 1973 through 1987. JAMA 271(6):431–37. 1994.

71. American Cancer Society, Inc. Cancer facts and figures 1994. Atlanta: American Cancer Society. 1994.

72. Kosary CL, Devesa SS. All cancer sites combined and all sites excluding lung and bronchus. In: Miller BA, Ries LAG, Hankey BF, et al., eds. SEER cancer statistics review, 1973–1990. Washington: U.S. Government Printing Office. II.1–II.51. 1993.

73. Olopade OI, Cummings S. Genetic counseling for cancer: Part I. Principles & practice of oncology updates 10(1):1–13. 1996.

74. Olopade OI, Cummings S. Genetic counseling for cancer: Part II. Principles & practice of oncology updates 10(2):1–11. 1996.

75. Ginsberg RJ, Kris MG, Armstrong JG. Chapter 23: Cancer of the lung. In: DeVita VT, Jr.; Hellman S; Rosenberg SA; eds. Cancer: Principles and practice of oncology. Philadelphia: J.B. Lippincott Company. 673–758. 1993.

76. Ries LAG, Schatzkin A, Kaplan R. Colon and rectum. In: Miller BA, Ries LAG, Hankey BF, et al., eds. SEER cancer statistics review, 1973–1990. Washington: U.S. Government Printing Office. VI.1–VI.22. 1993.

77. Cohen AM, Minsky BD, Schilsky RL. Chapter 30: Colon cancer. In: DeVita VT, Jr.; Hellman S; Rosenberg SA; eds. Cancer: Principles and practice of oncology. Philadelphia: J.B. Lippincott Company. 929–77. 1993.

78. Miller BA, Hayes RB, Potosky AL, et al. Prostate. In: Miller BA, Ries LAG, Hankey BF, et al., eds. SEER cancer statistics review, 1973–1990. Bethesda, Maryland: National Cancer Institute. Washington: U.S. Government Printing Office. XXII.1–XXII.15. 1993.

79. Hanks GE, Myers CE, Scardino PT. Chapter 35: Cancer of the prostate. In: DeVita VT, Jr.; Hellman S; Rosenberg SA; eds. Cancer: Principles and practice of oncology. Philadelphia: J.B. Lippincott Company. 1073–1113. 1993.

80. Morton RA. Racial differences in adenocarcinoma of the prostate in North American men. Urology 44(5):637–45. 1994.

81. Velentgas P, Daling JR. Risk factors for breast cancer in younger women. Monogr Natl Cancer Inst 16:15–22. 1994.

82. Nichols DH. The epidemiologic characteristics of breast cancer. Clin Obstet Gynecol 37(4):925–30. 1994.

83. Harris JR, Morrow M, Bonadonna G. Chapter 40: Cancer of the breast. In: DeVita VT, Jr.; Hellman S; Rosenberg SA; eds. Cancer: Principles and practice of oncology. Philadelphia: J.B. Lippincott Company. 1264–1332. 1993.

84. Kelsey JL. Breast cancer epidemiology: Summary and future directions. Epi Rev 15(1):256–63. 1993.

85. Sturgeon SR, Schairer C, Gail M, et al. Geographic variation in mortality from breast cancer among white women in the United States. J Natl Cancer Inst 87:1846–53. 1995.

86. National Heart, Lung, and Blood Institute. Morbidity and mortality: Chartbook on cardiovascular, lung, and blood diseases. Bethesda, Maryland: National Institutes of Health 36–42. 1994.

87. Centers for Disease Control and Prevention. Cardiovascular disease surveillance, stroke, 1980–1989. 1994.

88. Kistler JP, Ropper AH, Martin JB. Cerebrovascular diseases. In: Isselbacher KJ, Martin JB, Braunwald E, et al., eds. Harrison's principles of internal medicine. New York: McGraw-Hill, Inc. 2233–56. 1994.

89. Dyken ML, Wolf PA, Barnett HJM, et al. News from the American Heart Association: Risk factors in stroke. A statement for physicians by the Subcommittee on Risk Factors and Stroke of the Stroke Council. Stroke 15(6):1105–11. 1984.

90. Ostfeld AM, Wilk E. Epidemiology of stroke, 1980–1990: A progress report. Epi Rev 12: 253–6. 1990.

91. Casper ML, Wing S, Anda RF, Knowles M, Pollard RA. The shifting stroke belt: Changes in the geographic pattern of stroke mortality in the United States, 1962–1988. Stroke 26:755–60. 1995.

92. Lanska DJ, Peterson PM. Geographic variation in the decline of stroke mortality in the United States. Stroke 26:1159–65. 1995.

93. Wing S, Casper M, Davis WB, et al. Stroke mortality maps: United States whites aged 35–74 years, 1962–1982. Stroke 19:1507–13. 1988.

94. Lanska DJ, Peterson PM. Effects of interstate migration on the geographic distribution of stroke mortality in the United States. Stroke 26:554–61. 1995.

95. Baker SP, O'Neill B, Ginsburg MJ, Li G. The injury fact book. New York: Oxford University Press. 1992.

96. National Center for Environmental Health and Injury Control (NCEHIC). Position papers from the Third National Injury Control Conference. Washington: U.S. Government Printing Office. 261–96, 329–37. 1992.

97. Fingerhut LA, Jones C, Makuc DM. Firearm and motor vehicle injury mortality; variations by State, race, and ethnicity: United States 1990–1991. Advance data from vital and health statistics; no 242. Hyattsville, Maryland: National Center for Health Statistics. 1994.

98. Bates DV. Respiratory function in disease. Philadelphia: W.B. Saunders Company. 1989.

99. Cherniack NS. Chronic obstructive pulmonary disease. Philadelphia: W.B. Saunders Company. 227–32. 1991.

100. Centers for Disease Control. Update: Influenza activity - United States, 1991–1992 season. Morbidity and mortality weekly report 41(04): 63–5. 1992.

101. Centers for Disease Control. Update: Influenza activity - United States, 1992–1993 season. Morbidity and mortality weekly report 42(20):385–87. 1993.

102. LaForce FM, Nichol KL, Cox NJ. Influenza: virology, epidemiology, disease, and prevention. Am J Prev Med 10(supp):31–44. 1994.

103. Betts RF. Influenza virus. In: Mandell GL, Bennett JE, Dolin R, eds. Principles and practice of infectious diseases. New York: Churchill Livingstone. 1546–67. 1995.

104. Donowitz GR, Mandell GL. Acute pneumonia. In: Mandell GL, Bennett JE, Dolin R, eds. Principles and practice of infectious diseases. New York: Churchill Livingstone. 619–36. 1995.

105. Flegal KM, Ezzati TM, Harris MI, et al. Prevalence of diabetes in Mexican Americans, Cubans, and Puerto Ricans from the Hispanic Health and Nutrition Examination Survey, 1982–1984. Diabetes care 14(supp 3):628–38. 1991.

106. Lernmark A. Insulin-dependent diabetes mellitus. In: Davidson JK, ed. Clinical diabetes mellitus: A problem-oriented approach. New York: Theime Medical Publishers, Inc. 35–49. 1991.

107. Pareschi PL, Tomasi F. Epidemiology of diabetes mellitus. In: Morsiani M, ed. Epidemiology and screening of diabetes. Boca Raton, Florida: CRC Press, Inc. 77–114. 1989.

108. Dahlquist G. Non-genetic risk determinants of type 1 diabetes. Diabete Metab 20:251–57. 1994.

109. Centers for Disease Control and Prevention. Suicide among older persons - United States, 1980–1992. Morbidity and mortality weekly report 45(1):3–6. 1996.

110. O'Carroll PW, Rosenberg M, Mercy JA. Suicide. In: Rosenberg ML, Fenley MA, eds. Violence in America: A public health approach. New York: Oxford University Press. 184–96. 1991.

111. Monk M. Epidemiology of suicide. Epi Reviews 9:51–69. 1987.

112. Brent DA, Perper JA, Allman CJ, et al. The presence and accessibility of firearms in the homes of adolescent suicides. JAMA 266(21):2989–95. 1991.

113. Fingerhut LA. Firearm mortality among children, youth, and young adults 1–34 years of age, trends and current status: United States, 1985–1990. Advance data from vital and health statistics; no 231. Hyattsville, Maryland: National Center for Health Statistics. 1993.

114. National Center for Health Statistics. Excess deaths and other mortality measures for the Hispanic population. 1994.

115. Centers for Disease Control and Prevention. Deaths and hospitalizations from chronic liver disease and cirrhosis - United States, 1980–1989. Morbidity and mortality weekly report 41(52):969–73. 1993.

116. Centers for Disease Control. Chronic disease reports: Deaths from chronic liver disease - United States, 1986. Morbidity and mortality weekly report 38(46):792, 797–9. 1989.

117. Corrao G, Lepore AR, Torchio P, et al. Interaction between dietary pattern and alcohol intake on the risk of liver cirrhosis. Rev Epidemiol Sante Publique 43:7–17. 1995.

118. Boyer JL, Reuben A. Chronic hepatitis. In: Schiff L, Schiff ER, eds. Diseases of the liver, volume 1. Philadelphia: J.B. Lippincott Company. 586–637. 1993.

119. Centers for Disease Control and Prevention. Update: Mortality attributable to HIV infection among persons aged 25–44 years - United States, 1991 and 1992. Morbidity and mortality weekly report 42(45):869–72. 1993.

120. Centers for Disease Control and Prevention. HIV/AIDS surveillance report, 1994 6(2):30–1. 34. 1994.

121. Auerbach JD, Wypijewska C, Brodie HKH, eds. AIDS and behavior: An integrated approach. Washington: National Academy Press. 47–77. 1994.

122. Holmberg SD, Curran JW. The epidemiology of HIV infection in industrialized countries. In: Holmes KK, Mardh P, Sparling PF, Wiesner PJ, eds. Sexually transmitted diseases. New York: McGraw-Hill Information Services Company. 343–53. 1990.

123. Centers for Disease Control and Prevention. HIV/AIDS surveillance report, 1993 5(4):1. 1993.

124. Centers for Disease Control and Prevention. Trends in rates of homicide - United States, 1985–1994. Morbidity and mortality weekly report 45(22):460–4. 1996.

125. Rosenberg M, Mercy JA. Assaultive violence. In: Rosenberg ML, Fenley MA, eds. Violence in America: A public health approach. New York: Oxford University Press. 14–50. 1991.

126. Centers for Disease Control. Homicide among young black males - United States, 1978–1987. Morbidity and mortality weekly report 39(48):869–73. 1990.

127. Brillinger DR. The natural variability of vital rates and associated statistics. Biometrics 42:693–712. 1986.

128. Pickle LW. Measuring the dispersion of cancer mortality rates by the interquartile range. In: Page C, LePage R, eds. Computing science and statistics. Statistics of many parameters: Curves, images, spatial models. New York: Springer-Verlag. 496–500. 1992.

129. Manton KG, Woodbury MA, Stallard E, et al. Empirical Bayes procedures for stabilizing maps of U.S. cancer mortality rates. JASA 84:637–50. 1989.

130. Clayton D, Kaldor J. Empirical Bayes estimates of age-standardized relative risks for use in disease mapping. Biometrics 43:671–81. 1987.

131. Pickle LW, White AA. Effects of the choice of age-adjustment method on maps of death rates. Stat Med 14:615–27. 1995.

132. Wolfinger R, O'Connell M. Generalized linear mixed models: A pseudo-likelihood approach. J Stat Comp Simul 48:233–43. 1993.

133. Royall R. Model robust confidence intervals using maximum likelihood estimators. Int Stat Rev 54:221–6. 1986.

134. McCullagh P, Nelder JA. Generalized linear models. 2d ed. New York: Chapman and Hall. 1989.

135. Siegel PZ, Frazier EL, Mariolis P, et al. Behavioral risk factor surveillance, 1991: Monitoring progress toward the Nation's Year 2000 health objectives. In: CDC surveillance summaries, August 1993. Morbidity and mortality weekly report 42(SS–4):1–17. 1993.

Health Service Areas (HSA's) are aggregations of counties and independent cities based on a cluster analysis of where Medicare patients obtained routine hospital care in 1988 (31) (See fold-out map.). The clustering algorithm defined the HSA as an area within which its residents were more likely to seek hospital care than to travel outside it. The 805 HSA's used for this atlas differ from the original 802 HSA definitions (referred to as the "800-unlinked solution" by Makuc et al. (31)). These differences are as follows.

- HSA's for Alaska and Hawaii were created using the same clustering algorithm. The counties (or territories) included for these HSA's are the following.

    817: Ketchikan Gateway, Wrangell - Petersburg, Prince of Wales - Outer Ketchikan, AK
    818: Juneau, Sitka, Angoon, Haines, Skagway-Yakutat, AK
    819: Fairbanks North Star, Southeast Fairbanks, Upper Yukon, Yukon - Koyukuk, AK
    820: Remainder of AK
    821: Honolulu, Maui, Kalawao, HI
    822: Kauai, HI
    823: Hawaii, HI

- The islands of Nantucket, Massachusetts (HSA 111) and Duke Island, Massachusetts (HSA 120) were combined with Boston, Massachusetts (HSA 22) and Rockland, New York (HSA 133) was grouped with Bergen City, New Jersey (HSA 36) to achieve a minimum HSA size of 250 square miles for visibility on the maps. Only New York City (HSA 94) remains below this minimum. It is shown at larger scale east of its actual location and is labeled "NYC" on the maps.

- New York City (HSA 94) was redefined to be consistent with its census designation. From the original Series Report definitions, Kings and Richmond counties, New York (HSA 113) and Queens, New York (removed from HSA 83) were added to HSA 94.

Names have been developed for the 805 HSA's to assist readers in recognizing their geographic location (DD Ingram, personal communication). The HSA's were originally identified only by numbers. The primary identification of the HSA's is by county name because counties were used in the creation of the HSA's. For some HSA's a place name (for a city, town, or other Census Designated Place (CDP)) was also chosen for use in the HSA name because it may be better known to readers than the county name. Therefore, to meet the objective of recognizability, the following approach was taken to create the HSA names.

- A maximum of two county names was used in an HSA name. For HSA's comprised of only one county, the name of that county appears in the HSA name. For HSA's comprised of two counties or more, the county with the largest number of Medicare hospital stays in 1988 (primary county) appears first in the HSA name and the county with the second largest number of hospital stays (secondary county) appears second. The two-letter State abbreviation was included with each county name as some HSA's include counties from more than one State.

- If the primary or secondary county in the HSA was part of a Metropolitan Statistical Area as defined by the U.S. Bureau of the Census in 1990, a place name (for a city, town, CDP, etc.) was included in the HSA name. The place name used in the HSA name was the name of the place with the largest 1990 population from either the primary or secondary county in the HSA. The place name appears in the HSA name in parentheses, following either the primary or secondary county name.

    - To avoid redundancy, place names were not included in the names of five HSA's for which the county was actually an independent city. These HSA's are Washington, D.C.-Montgomery, Maryland (HSA 61); St. Louis, Missouri-St. Louis city, Missouri (HSA 541); Newport News city, Virginia -Hampton city, Virginia (HSA 5); and Norfolk/Portsmouth city, Virginia-Virginia Beach city, Virginia (HSA 6).

    - A place name was not included in the HSA name for Nassau, New York-Suffolk, New York (HSA 83), Washington, Pennsylvania-Fayette, Pennsylvania (HSA 100), or St. Croix, Wisconsin-Goodhue, Minnesota (HSA 370) because their primary and secondary counties include a number of small communities that are suburbs of a large metropolitan area. It was not possible to select one of them as the principal place in the county.

- A place name was not included in the HSA name if the primary or secondary county in the HSA was not part of a Metropolitan Statistical Area. For these HSA's, the population of the largest place tended to be small or the county was composed of numerous small towns with similar population size.

# FOLD OUT MAP

| HSA number | Number of counties in HSA | HSA name |
|---|---|---|
| 1 | 5 | Allegany (Cumberland), MD - Garrett, MD |
| 2 | 6 | Kenton (Covington), KY - Campbell, KY |
| 3 | 5 | Sussex, DE - Wicomico, MD |
| 4 | 3 | Hartford (Hartford), CT - Windham, CT |
| 5 | 6 | Newport News city, VA - Hampton city, VA |
| 6 | 7 | Norfolk/Portsmouth city, VA - Virginia Beach city, VA |
| 7 | 6 | Kanawha (Charleston), WV - Putnam, WV |
| 8 | 5 | Schuylkill, PA - Montour, PA |
| 9 | 4 | Cumberland (Portland), ME - Knox, ME |
| 10 | 3 | Albany (Albany), NY - Rensselaer, NY |
| 11 | 3 | Floyd, KY - Johnson, KY |
| 12 | 11 | McCracken, KY - Graves, KY |
| 13 | 3 | Pike, KY - Logan, WV |
| 14 | 9 | Roanoke (Roanoke), VA - Campbell, VA |
| 15 | 5 | Grafton, NH - Washington, VT |
| 16 | 5 | Baltimore (Baltimore), MD - Anne Arundel, MD |
| 17 | 4 | Penobscot (Bangor), ME - Hancock, ME |
| 18 | 13 | Fayette (Lexington - Fayette), KY - Perry, KY |
| 19 | 5 | Broome (Binghamton), NY - Bradford, PA |
| 20 | 5 | Providence (Providence), RI - New London, CT |
| 21 | 4 | Ontario (Geneva), NY - Wayne, NY |
| 22 | 7 | Middlesex, MA - Suffolk (Boston), MA |
| 23 | 4 | Camden (Camden), NJ - Burlington, NJ |
| 24 | 6 | Ohio (Wheeling), WV - Belmont, OH |
| 25 | 8 | Frederick, VA - Berkeley, WV |
| 26 | 3 | Clearfield, PA - Centre (State College), PA |
| 27 | 5 | Boyle, KY - Lincoln, KY |
| 28 | 5 | Philadelphia (Philadelphia), PA - Montgomery, PA |
| 29 | 6 | Warren, KY - Logan, KY |
| 30 | 4 | Alleghany, VA - Greenbrier, WV |
| 31 | 4 | Monongalia, WV - Marion, WV |
| 32 | 2 | Hampden (Springfield), MA - Hampshire, MA |
| 33 | 20 | Henrico (Richmond), VA - Prince Edward, VA |
| 34 | 8 | Wood (Parkersburg), WV - Washington, OH |
| 35 | 5 | Cattaraugus, NY - McKean, PA |
| 36 | 4 | Bergen, NJ - Hudson (Jersey City), NJ |
| 37 | 3 | Pulaski, KY - Wayne, KY |
| 38 | 3 | Kennebec, ME - Somerset, ME |
| 39 | 5 | Mercer, WV - Tazewell, VA |
| 40 | 2 | Henderson (Henderson), KY - Union, KY |
| 41 | 4 | Westchester (Yonkers), NY - Dutchess, NY |
| 42 | 6 | Allegheny (Pittsburgh), PA - Westmoreland, PA |
| 43 | 4 | Dauphin (Harrisburg), PA - Cumberland, PA |
| 44 | 2 | Lycoming (Williamsport), PA - Clinton, PA |
| 45 | 7 | Hopkins, KY - Christian (Hopkinsville), KY |
| 46 | 9 | Cabell (Huntington), WV - Boyd, KY |
| 47 | 2 | Lackawanna (Scranton), PA - Wayne, PA |
| 48 | 3 | York (York), PA - Frederick, MD |
| 49 | 4 | Chittenden (Burlington), VT - Franklin, VT |
| 50 | 4 | Randolph, WV - Barbour, WV |
| 51 | 4 | Whitley, KY - Laurel, KY |
| 52 | 3 | Venango, PA - Clarion, PA |
| 53 | 4 | Barren, KY - Monroe, KY |
| 54 | 7 | Erie (Buffalo), NY - Monroe, NY |
| 55 | 3 | Wise, VA - Lee, VA |
| 56 | 3 | Onondaga (Syracuse), NY - Cayuga, NY |
| 57 | 4 | Cambria, PA - Blair (Altoona), PA |
| 58 | 4 | Otsego, NY - Delaware, NY |
| 59 | 3 | Oneida (Utica), NY - Herkimer, NY |
| 60 | 4 | Raleigh, WV - Fayette, WV |
| 61 | 5 | Washington, DC - Montgomery, MD |
| 62 | 4 | Madison, KY - Rockcastle, KY |
| 63 | 3 | Rockingham, VA - Page, VA |
| 64 | 2 | Atlantic (Atlantic City), NJ - Cape May, NJ |
| 65 | 3 | Steuben, NY - Chemung (Elmira), NY |
| 66 | 4 | Essex (Newark), NJ - Union, NJ |
| 67 | 4 | Rowan, KY - Morgan, KY |
| 68 | 2 | Bristol (New Bedford), MA - Newport, RI |
| 69 | 4 | Alexandria city, VA - Arlington - Alexandria (Arlington), VA |
| 70 | 4 | Montgomery, VA - Pulaski, VA |
| 71 | 3 | Halifax, VA - Mecklenburg, VA |
| 72 | 3 | Franklin, PA - Washington (Hagerstown), MD |
| 73 | 3 | Grayson, VA - Alleghany, NC |
| 74 | 2 | Essex (Lynn), MA - Rockingham, NH |
| 75 | 3 | New Castle (Wilmington), DE - Harford, MD |
| 76 | 2 | Montgomery (Amsterdam), NY - Fulton, NY |
| 77 | 4 | Dinwiddie (Petersburg), VA - Prince George, VA |
| 78 | 3 | Luzerne (Wilkes - Barre), PA - Columbia, PA |
| 79 | 2 | Henry, VA - Patrick, VA |
| 80 | 3 | St. Lawrence, NY - Jefferson, NY |
| 81 | 3 | Clinton, NY - Franklin, NY |
| 82 | 4 | Taylor, KY - Russell, KY |
| 83 | 2 | Nassau, NY - Suffolk, NY |
| 84 | 4 | Lehigh (Allentown), PA - Northampton, PA |
| 85 | 3 | New Haven (New Haven), CT - Litchfield, CT |
| 86 | 3 | Orange (Newburgh), NY - Sullivan, NY |
| 87 | 2 | Morris (Parsippany - Troy Hills Township), NJ - Sussex, NJ |
| 88 | 5 | Schenectady (Schenectady), NY - Warren, NY |
| 89 | 5 | Hardin, KY - Grayson, KY |
| 90 | 2 | Cheshire, NH - Windham, VT |
| 91 | 4 | Hillsborough (Manchester), NH - Merrimack, NH |
| 92 | 6 | Harrison, WV - Lewis, WV |
| 93 | 2 | Warren (Phillipsburg), NJ - Hunterdon, NJ |
| 94 | 5 | New York, NY - Kings (New York), NY |
| 95 | 3 | Androscoggin (Lewiston), ME - Oxford, ME |
| 96 | 3 | Bell, KY - Claiborne, TN |
| 97 | 3 | Augusta, VA - Rockbridge, VA |
| 98 | 2 | York, ME - Strafford (Rochester), NH |
| 99 | 10 | Albemarle (Charlottesville), VA - Culpeper, VA |
| 100 | 3 | Washington, PA - Fayette, PA |
| 101 | 2 | Worcester (Worcester), MA - Franklin, MA |

| HSA number | Number of counties in HSA | HSA name |
|---|---|---|
| 102 | 2 | Bourbon (Paris), KY - Nicholas, KY |
| 103 | 3 | Orleans, VT - Caledonia, VT |
| 104 | 2 | Cumberland, KY - Clinton, KY |
| 105 | 2 | Cortland, NY - Tompkins, NY |
| 106 | 3 | Erie (Erie), PA - Chautauqua, NY |
| 107 | 4 | Talbot, MD - Dorchester, MD |
| 108 | 2 | Ocean (Brick Township), NJ - Monmouth, NJ |
| 109 | 2 | Prince William (Dale City), VA - Fauquier, VA |
| 110 | 3 | Mifflin, PA - Huntingdon, PA |
| 112 | 3 | Berkshire (Pittsfield), MA - Columbia, NY |
| 114 | 3 | Franklin, KY - Owen, KY |
| 115 | 4 | Calloway, KY - Carroll, TN |
| 116 | 3 | Mason, KY - Fleming, KY |
| 117 | 1 | Crawford, PA |
| 119 | 2 | Harrison, KY - Robertson, KY |
| 121 | 1 | Fairfield (Bridgeport), CT |
| 122 | 1 | Rutland, VT |
| 123 | 1 | Letcher, KY |
| 124 | 1 | Kent, MD |
| 125 | 1 | Elk, PA |
| 126 | 1 | Mercer (Trenton), NJ |
| 127 | 1 | Cumberland (Vineland), NJ |
| 128 | 1 | Tioga, PA |
| 129 | 1 | Lawrence, PA |
| 130 | 2 | Greensville, VA - Brunswick, VA |
| 131 | 2 | Montgomery, KY - Bath, KY |
| 132 | 2 | Pittsylvania (Danville), VA - Caswell, NC |
| 135 | 4 | Spotsylvania, VA - Caroline, VA |
| 136 | 1 | Aroostook, ME |
| 137 | 2 | Northampton, VA - Accomack, VA |
| 138 | 2 | Coos, NH - Essex, VT |
| 139 | 1 | Berks (Reading), PA |
| 140 | 1 | Lancaster (Lancaster), PA |
| 141 | 6 | Hamilton (Chattanooga), TN - Catoosa, GA |
| 142 | 6 | Orange (Orlando), FL - Volusia, FL |
| 143 | 9 | Chatham (Savannah), GA - Beaufort, SC |
| 144 | 9 | Dougherty (Albany), GA - Early, GA |
| 145 | 2 | Whitfield, GA - Murray, GA |
| 146 | 9 | Shelby (Memphis), TN - Panola, MS |
| 147 | 8 | Knox (Knoxville), TN - Blount, TN |
| 148 | 7 | Davidson (Nashville - Davidson), TN - Dickson, TN |
| 149 | 5 | Forsyth (Winston - Salem), NC - Surry, NC |
| 150 | 8 | Jefferson (Birmingham), AL - Walker, AL |
| 151 | 6 | Sullivan (Kingsport), TN - Washington, VA |
| 152 | 12 | Richmond (South Augusta), GA - Aiken, SC |
| 153 | 9 | Fulton (Atlanta), GA - DeKalb, GA |
| 154 | 5 | Floyd, GA - Bartow, GA |
| 155 | 6 | Bay (Panama City), FL - Jackson, FL |
| 156 | 4 | Tuscaloosa (Tuscaloosa), AL - Pickens, AL |
| 157 | 8 | Hall, GA - Union, GA |
| 158 | 9 | Duval (Jacksonville), FL - Glynn, GA |
| 159 | 10 | Alachua (Gainesville), FL - Columbia, FL |
| 160 | 4 | Richland (Columbia), SC - Lexington, SC |
| 161 | 5 | Mobile (Mobile), AL - Baldwin, AL |
| 162 | 7 | Houston (Dothan), AL - Coffee, AL |
| 163 | 6 | Escambia (Pensacola), FL - Okaloosa, FL |
| 164 | 8 | Clarke (Athens), GA - Barrow, GA |
| 165 | 4 | Lee (Cape Coral), FL - Collier, FL |
| 166 | 9 | Muscogee (Columbus), GA - Russell, AL |
| 167 | 3 | Mecklenburg (Charlotte), NC - Union, NC |
| 168 | 3 | New Hanover (Wilmington), NC - Brunswick, NC |
| 169 | 3 | Washington (Johnson City), TN - Carter, TN |
| 170 | 5 | Durham (Durham), NC - Vance, NC |
| 171 | 7 | Montgomery (Montgomery), AL - Covington, AL |
| 172 | 6 | Troup (La Grange), GA - Coweta, GA |
| 173 | 4 | Bradley, TN - Gilmer, GA |
| 174 | 4 | Ware, GA - Bacon, GA |
| 175 | 4 | Dallas, AL - Marengo, AL |
| 176 | 4 | Orangeburg, SC - Bamberg, SC |
| 177 | 4 | Calhoun (Anniston), AL - Carroll, GA |
| 178 | 3 | Thomas, GA - Grady, GA |
| 179 | 4 | Lee (Auburn), AL - Elmore, AL |
| 180 | 6 | Lowndes, GA - Cook, GA |
| 181 | 3 | Obion, TN - Weakley, TN |
| 182 | 4 | Greenville (Greenville), SC - Anderson, SC |
| 183 | 8 | Leon (Tallahassee), FL - Madison, FL |
| 184 | 5 | Florence (Florence), SC - Darlington, SC |
| 185 | 2 | Morgan (Decatur), AL - Lawrence, AL |
| 186 | 4 | Guilford (Greensboro), NC -Rockingham, NC |
| 187 | 5 | Greenwood, SC - Laurens, SC |
| 188 | 8 | Madison (Jackson), TN - Gibson, TN |
| 189 | 4 | Tift, GA - Ben Hill, GA |
| 190 | 5 | Cobb (Marietta), GA - Cherokee, GA |
| 191 | 4 | Spartanburg (Spartanburg), SC - Union, SC |
| 192 | 2 | Iredell (Statesville), NC - Alexander, NC |
| 193 | 11 | Bibb (Macon), GA - Houston, GA |
| 194 | 3 | Watauga, NC - Ashe, NC |
| 195 | 6 | Pitt, NC - Beaufort, NC |
| 196 | 3 | Sumter, SC - Clarendon, SC |
| 197 | 5 | Sumter, GA - Crisp, GA |
| 198 | 4 | Wake (Raleigh), NC - Wilson, NC |
| 199 | 2 | Marion, SC - Dillon, SC |
| 200 | 3 | Dade (Miami), FL - Broward, FL |
| 201 | 3 | Baldwin, GA - Putnam, GA |
| 202 | 3 | Polk (Lakeland), FL - Highlands, FL |
| 203 | 4 | Orange (Chapel Hill), NC - Harnett, NC |
| 204 | 2 | Spalding (Griffin), GA - Butts, GA |
| 205 | 4 | Moore, NC - Richmond, NC |
| 206 | 8 | Laurens, GA - Dodge, GA |
| 207 | 4 | Robeson, NC - Columbus, NC |
| 208 | 4 | Maury, TN - Giles, TN |
| 209 | 4 | Macon, NC - Jackson, NC |
| 210 | 4 | Madison (Huntsville), AL - Jackson, AL |
| 211 | 5 | Rutherford (Murfreesboro), TN - Warren, TN |
| 212 | 5 | Charleston (Charleston), SC - Colleton, SC |
| 213 | 3 | Sarasota (Sarasota), FL - Charlotte, FL |
| 214 | 4 | Edgecombe, NC - Halifax, NC |
| 215 | 6 | Putnam, TN - Overton, TN |
| 216 | 3 | Stephens, GA - Franklin, GA |
| 217 | 4 | Hamblen (Morristown), TN - Jefferson, TN |
| 218 | 4 | Gaston (Gastonia), NC - Cleveland, NC |

| HSA number | Number of counties in HSA | HSA name | HSA number | Number of counties in HSA | HSA name |
|---|---|---|---|---|---|
| 219 | 4 | Lauderdale (Florence), AL - Colbert, AL | 277 | 5 | Peoria (Peoria), IL - Tazewell, IL |
| 220 | 2 | Newton (Covington), GA - Jasper, GA | 278 | 4 | Brown (Green Bay), WI - Door, WI |
| 221 | 4 | Palm Beach (West Palm Beach), FL - St. Lucie, FL | 279 | 5 | Champaign (Champaign), IL - Coles, IL |
| 222 | 4 | Bulloch, GA - Emanuel, GA | 280 | 4 | Milwaukee (Milwaukee), WI - Waukesha, WI |
| 223 | 3 | Cumberland, TN - Fentress, TN | 281 | 5 | Franklin (Columbus), OH - Delaware, OH |
| 224 | 4 | Etowah (Gadsden), AL - Marshall, AL | 282 | 5 | Wood, WI - Marathon (Wausau), WI |
| 225 | 5 | Buncombe (Asheville), NC - Henderson, NC | 283 | 4 | Gallia, OH - Mason, WV |
| 226 | 5 | Anderson (Oak Ridge), TN - Roane, TN | 284 | 6 | Oneida, WI - Gogebic, MI |
| 227 | 4 | Pinellas, FL - Hillsborough (Tampa), FL | 285 | 4 | Ingham (Lansing), MI - Shiawassee, MI |
| 228 | 3 | Decatur, GA - Seminole, GA | 286 | 5 | Ramsey (St. Paul), MN - Polk, WI |
| 229 | 3 | Catawba (Hickory), NC - Burke, NC | 287 | 4 | Cook (Chicago), IL - Du Page, IL |
| 230 | 2 | Wayne, GA - Appling, GA | 288 | 4 | Cuyahoga (Cleveland), OH - Lake, OH |
| 231 | 5 | Sumner (Hendersonville), TN - Wilson, TN | 289 | 8 | St. Louis (Duluth), MN - Douglas, WI |
| 232 | 3 | Lawrence, TN - Wayne, TN | 290 | 6 | La Crosse (La Crosse), WI - Monroe, WI |
| 233 | 2 | Marion (Ocala), FL - Citrus, FL | 291 | 4 | Winnebago (Rockford), IL - Lee, IL |
| 234 | 3 | Montgomery (Clarksville), TN - Houston, TN | 292 | 6 | Allen (Lima), OH - Mercer, OH |
| 235 | 3 | Cabarrus (Concord), NC - Rowan, NC | 293 | 5 | Marquette, MI - Delta, MI |
| 236 | 3 | Coffee, GA - Jeff Davis, GA | 294 | 5 | Emmet, MI - Cheboygan, MI |
| 237 | 2 | Brevard (Palm Bay), FL - Indian River, FL | 295 | 4 | Montgomery (Dayton), OH - Greene, OH |
| 238 | 4 | Lenoir, NC - Wayne, NC | 296 | 4 | Muskegon (Muskegon), MI - Mason, MI |
| 239 | 4 | Coffee, TN - Franklin, TN | 297 | 2 | St. Clair (Port Huron), MI - Sanilac, MI |
| 240 | 3 | Avery, NC - Mitchell, NC | 298 | 5 | Eau Claire (Eau Claire), WI - Chippewa, WI |
| 241 | 3 | Talladega, AL - Clay, AL | 299 | 4 | Madison (Alton), IL - Jersey, IL |
| 242 | 5 | Craven, NC - Carteret, NC | 300 | 5 | Tippecanoe (Lafayette), IN - Clinton, IN |
| 243 | 4 | Hertford, NC - Chowan, NC | 301 | 7 | Dane (Madison), WI - Sauk, WI |
| 244 | 2 | York (Rock Hill), SC - Chester, SC | 302 | 4 | Dubuque (Dubuque), IA - Stephenson, IL |
| 245 | 2 | Hardin, TN - McNairy, TN | 303 | 2 | Will (Joliet), IL - Grundy, IL |
| 246 | 2 | Horry, SC - Georgetown, SC | 304 | 6 | Allen (Fort Wayne), IN - Whitley, IN |
| 247 | 2 | Marion, AL - Fayette, AL | 305 | 4 | Macon (Decatur), IL - Shelby, IL |
| 248 | 3 | Dyer, TN - Lauderdale, TN | 306 | 5 | Winnebago (Oshkosh), WI - Fond du Lac, WI |
| 249 | 2 | Kershaw, SC - Lancaster, SC | | | |
| 250 | 2 | Washington, GA - Jefferson, GA | 307 | 4 | Rock Island (Moline), IL - Henry, IL |
| 251 | 2 | St. Johns (St. Augustine), FL - Putnam, FL | 308 | 4 | Lake (Gary), IN - Porter, IN |
| 252 | 2 | Greene, TN - Cocke, TN | 309 | 5 | Kent (Grand Rapids), MI - Montcalm, MI |
| 253 | 2 | Elbert, GA - Wilkes, GA | 310 | 6 | Knox, IN - Daviess, IN |
| 254 | 1 | Colquitt, GA | 311 | 6 | Vigo (Terre Haute), IN - Sullivan, IN |
| 256 | 1 | Wilkes, NC | 312 | 4 | St. Joseph (South Bend), IN - Marshall, IN |
| 257 | 1 | Osceola (Kissimmee), FL | 313 | 4 | Bartholomew, IN - Jackson, IN |
| 258 | 2 | Cherokee, NC - Clay, NC | 314 | 2 | Washburn, WI - Burnett, WI |
| 259 | 1 | Butler, AL | 315 | 5 | Dickinson, MI - Marinette, WI |
| 260 | 1 | Bedford, TN | 316 | 5 | Daviess (Owensboro), KY - Ohio, KY |
| 261 | 1 | McDowell, NC | 317 | 4 | Wexford, MI - Osceola, MI |
| 262 | 2 | Cumberland (Fayetteville), NC - Sampson, NC | 318 | 8 | Sangamon (Springfield), IL - McDonough, IL |
| 263 | 1 | Scott, TN | 319 | 3 | Morgan, IL - Greene, IL |
| 264 | 4 | Pasquotank, NC - Camden, NC | 320 | 2 | Ottawa (Holland), MI - Allegan, MI |
| 266 | 1 | Manatee (Bradenton), FL | 321 | 7 | Jefferson (Madison), IN - Dearborn, IN |
| 267 | 1 | Alamance (Burlington), NC | 322 | 3 | Saginaw (Saginaw), MI - Huron, MI |
| 268 | 1 | Rabun, GA | 323 | 3 | Delaware (Muncie), IN - Randolph, IN |
| 269 | 3 | Upson, GA - Lamar, GA | 324 | 2 | Knox, IL - Warren, IL |
| 270 | 7 | Hamilton (Cincinnati), OH - Butler, OH | 325 | 4 | St. Clair (Belleville), IL - Randolph, IL |
| 271 | 6 | Grand Traverse, MI - Manistee, MI | 326 | 3 | Rock (Janesville), WI - Green, WI |
| 272 | 9 | Jefferson (Louisville), KY - Shelby, KY | 327 | 3 | Berrien (Benton Harbor), MI - Van Buren, MI |
| 273 | 6 | Vanderburgh (Evansville), IN - Gibson, IN | | | |
| 274 | 5 | Wayne (Detroit), MI - Oakland, MI | 328 | 2 | Genesee (Flint), MI - Lapeer, MI |
| 275 | 7 | Marion (Indianapolis), IN - Hendricks, IN | 329 | 2 | Lawrence, IN - Orange, IN |
| 276 | 5 | Lucas (Toledo), OH - Monroe, MI | 330 | 4 | Midland (Midland), MI - Isabella, MI |

| HSA number | Number of counties in HSA | HSA name |
|---|---|---|
| 331 | 4 | Williamson, IL - Jackson, IL |
| 332 | 4 | Wells, IN - Jay, IN |
| 333 | 4 | Vermilion, IL - Edgar, IL |
| 334 | 2 | Montgomery, IL - Macoupin, IL |
| 335 | 2 | Jefferson, IL - Wayne, IL |
| 336 | 4 | La Salle, IL - Bureau, IL |
| 337 | 4 | Scioto, OH - Ross, OH |
| 338 | 3 | McLean (Bloomington), IL - De Witt, IL |
| 339 | 4 | Floyd (New Albany), IN - Harrison, IN |
| 340 | 3 | Des Moines, IA - Henry, IA |
| 341 | 4 | Monroe (Bloomington), IN - Greene, IN |
| 342 | 5 | Bay (Bay City), MI - Ogemaw, MI |
| 343 | 2 | Kankakee (Kankakee), IL - Iroquois, IL |
| 344 | 2 | Outagamie (Appleton), WI - Waupaca, WI |
| 345 | 3 | Mahoning (Youngstown), OH - Mercer, PA |
| 346 | 2 | Clark (Springfield), OH - Champaign, OH |
| 347 | 5 | Stark (Canton), OH - Tuscarawas, OH |
| 348 | 2 | Kalamazoo (Kalamazoo), MI - St. Joseph, MI |
| 349 | 2 | Elkhart (Elkhart), IN - Kosciusko, IN |
| 350 | 3 | Crawford, WI - Clayton, IA |
| 351 | 4 | Richland, IL - Clay, IL |
| 352 | 3 | Summit (Akron), OH - Medina, OH |
| 353 | 6 | Adams, IL - Marion, Mo |
| 354 | 5 | Marion, OH - Crawford, OH |
| 355 | 3 | Sheboygan (Sheboygan), WI - Manitowoc, WI |
| 356 | 4 | Williams, OH - Defiance, OH |
| 357 | 4 | Ashland, WI - Price, WI |
| 358 | 2 | Marion, IL - Washington, IL |
| 359 | 3 | Houghton, MI - Baraga, MI |
| 360 | 2 | Jefferson (Steubenville), OH - Harrison, OH |
| 361 | 3 | Clinton, IA - Whiteside, IL |
| 362 | 2 | Henry (New Castle), IN - Hancock, IN |
| 363 | 2 | Effingham, IL - Fayette, IL |
| 364 | 3 | Howard (Kokomo), IN - Cass, IN |
| 365 | 2 | Clark (Jeffersonville), IN - Scott, IN |
| 366 | 4 | Lorain (Lorain), OH - Erie, OH |
| 367 | 3 | Lee, IA - Hancock, IL |
| 368 | 4 | Fairfield (Lancaster), OH - Athens, OH |
| 369 | 2 | Richland (Mansfield), OH - Ashland, OH |
| 370 | 3 | St. Croix, WI - Goodhue, MN |
| 371 | 4 | Alpena, MI - Presque Isle, MI |
| 372 | 2 | Clinton, OH - Highland, OH |
| 373 | 3 | Kane (Aurora), IL - De Kalb, IL |
| 374 | 2 | Barron, WI - Rusk, WI |
| 375 | 4 | Jackson (Jackson), MI - Lenawee, MI |
| 376 | 2 | Miami (Piqua), OH - Shelby, OH |
| 377 | 6 | Muskingum, OH - Guernsey, OH |
| 378 | 2 | La Porte, IN - Starke, IN |
| 379 | 3 | Shawano, WI - Langlade, WI |
| 380 | 3 | Columbiana, OH - Hancock (Weirton), WV |
| 381 | 2 | Calhoun (Battle Creek), MI - Barry, MI |
| 382 | 2 | Racine (Racine), WI - Kenosha, WI |
| 383 | 2 | White, IL - Hamilton, IL |
| 384 | 4 | Saline, IL - Hardin, IL |
| 385 | 3 | Wayne, IN - Fayette, IN |
| 386 | 2 | Hancock, OH - Seneca, OH |
| 387 | 2 | Jefferson, WI - Walworth, WI |
| 388 | 2 | Licking (Newark), OH - Knox, OH |
| 389 | 3 | Grant, IN - Wabash, IN |
| 390 | 2 | Madison (Anderson), IN - Hamilton, IN |
| 391 | 2 | Juneau, WI - Adams, WI |
| 392 | 3 | Crawford, MI - Otsego, MI |
| 394 | 1 | Dubois, IN |
| 395 | 1 | Winneshiek, IA |
| 396 | 1 | Rice, MN |
| 398 | 1 | Logan, OH |
| 399 | 1 | Jackson, WI |
| 400 | 1 | Portage, WI |
| 401 | 1 | Boone (Lebanon), IN |
| 402 | 1 | Montgomery, IN |
| 403 | 7 | Orleans (New Orleans), LA - Jefferson, LA |
| 404 | 9 | Bowie (Texarkana), TX - Miller, AR |
| 405 | 15 | Potter (Amarillo), TX - Moore, TX |
| 406 | 13 | Lubbock (Lubbock), TX - Lamb, TX |
| 407 | 2 | Baxter, AR - Marion, AR |
| 408 | 8 | Harris (Houston), TX - Montgomery, TX |
| 409 | 5 | Forrest, MS - Covington, MS |
| 410 | 12 | Bexar (San Antonio), TX - Guadalupe, TX |
| 411 | 8 | Hinds (Jackson), MS - Rankin, MS |
| 412 | 7 | Lauderdale, MS - Newton, MS |
| 413 | 6 | Jefferson (Beaumont), TX - Orange, TX |
| 414 | 6 | Tulsa (Tulsa), OK - Creek, OK |
| 415 | 4 | El Paso (El Paso), TX - Culberson, TX |
| 416 | 7 | Caddo (Shreveport), LA - Webster, LA |
| 417 | 5 | Oklahoma (Oklahoma City), OK - Pottawatomie, OK |
| 418 | 5 | Lee, MS - Prentiss, MS |
| 419 | 8 | East Baton Rouge (Baton Rouge), LA - Ascension, LA |
| 420 | 8 | Wichita (Wichita Falls), TX - Young, TX |
| 421 | 8 | Sebastian (Fort Smith), AR - Crawford, AR |
| 422 | 3 | Coahoma, MS - Quitman, MS |
| 423 | 2 | Tangipahoa, LA - St. Helena, LA |
| 424 | 5 | Lafayette (Lafayette), LA - Iberia, LA |
| 425 | 6 | Travis (Austin), TX - Williamson, TX |
| 426 | 12 | Tom Green (San Angelo), TX - McCulloch, TX |
| 427 | 2 | Hidalgo (McAllen), TX - Starr, TX |
| 428 | 9 | Taylor (Abilene), TX - Jones, TX |
| 429 | 7 | Garfield (Enid), OK - Kingfisher, OK |
| 430 | 4 | Cleveland (Norman), OK - Garvin, OK |
| 431 | 3 | Warren, MS - Madison, LA |
| 432 | 9 | Pulaski (Little Rock), AR - Saline, AR |
| 433 | 7 | Victoria (Victoria), TX - Lavaca, TX |
| 434 | 5 | Tarrant (Fort Worth), TX - Johnson, TX |
| 435 | 5 | Adams, MS - Concordia, LA |
| 436 | 4 | Grayson (Sherman), TX - Bryan, OK |
| 437 | 9 | Nueces (Corpus Christi), TX - San Patricio, TX |
| 438 | 4 | Lamar, TX - Red River, TX |
| 439 | 4 | Lincoln, LA - Union, LA |
| 440 | 2 | Beckham, OK - Roger Mills, OK |
| 441 | 4 | Smith (Tyler), TX - Henderson, TX |
| 442 | 2 | Pope, AR - Yell, AR |

| HSA number | Number of counties in HSA | HSA name |
|---|---|---|
| 443 | 7 | Ouachita (Monroe), LA - Richland, LA |
| 444 | 5 | Ector (Odessa), TX - Ward, TX |
| 445 | 5 | Muskogee, OK - Cherokee, OK |
| 446 | 4 | Washington (Fayetteville), AR - Benton, AR |
| 447 | 4 | Nacogdoches, TX - Shelby, TX |
| 448 | 5 | Garland, AR - Hot Spring, AR |
| 449 | 4 | Angelina, TX - Walker, TX |
| 450 | 6 | Rapides (Alexandria), LA - La Salle, LA |
| 451 | 5 | Washington, OK - Montgomery, KS |
| 452 | 4 | Bell (Killeen), TX - Milam, TX |
| 453 | 8 | Dallas (Dallas), TX - Collin, TX |
| 454 | 4 | Gregg (Longview), TX - Rusk, TX |
| 455 | 4 | Jones, MS - Wayne, MS |
| 456 | 3 | Harrison (Biloxi), MS - Hancock, MS |
| 457 | 3 | White, AR - Cleburne, AR |
| 458 | 3 | Wilbarger, TX - Hardeman, TX |
| 459 | 3 | Lafayette, MS - Calhoun, MS |
| 460 | 4 | Gray, TX - Wheeler, TX |
| 461 | 4 | Lowndes, MS - Clay, MS |
| 462 | 6 | McLennan (Waco), TX - Hill, TX |
| 463 | 2 | St. Landry, LA - Evangeline, LA |
| 464 | 5 | Brazos (Bryan), TX - Washington, TX |
| 465 | 4 | Titus, TX - Camp, TX |
| 466 | 3 | Pittsburg, OK - Pushmataha, OK |
| 467 | 3 | Lafourche, LA - Terrebonne (Houma), LA |
| 468 | 4 | Brown, TX - Coleman, TX |
| 469 | 5 | Woodward, OK - Ellis, OK |
| 470 | 5 | Calcasieu (Lake Charles), LA - Beauregard, LA |
| 471 | 2 | Jackson (Pascagoula), MS - George, MS |
| 472 | 3 | Payne, OK - Pawnee, OK |
| 473 | 6 | Jefferson (Pine Bluff), AR - Bradley, AR |
| 474 | 4 | Carter, OK - Marshall, OK |
| 475 | 2 | Custer, OK - Washita, OK |
| 476 | 2 | Grady, OK - Caddo, OK |
| 477 | 4 | Pike, MS - Marion, MS |
| 478 | 4 | Pontotoc, OK - Seminole, OK |
| 479 | 2 | Palo Pinto, TX - Jack, TX |
| 480 | 2 | Chicot, AR - Ashley, AR |
| 481 | 3 | Hale, TX - Floyd, TX |
| 482 | 3 | Union, MS - Tippah, MS |
| 483 | 3 | Jackson, OK - Greer, OK |
| 484 | 4 | Oktibbeha, MS - Webster, MS |
| 485 | 3 | Harrison (Marshall), TX - Cass, TX |
| 486 | 3 | Union, AR - Columbia, AR |
| 487 | 4 | Leflore, MS - Bolivar, MS |
| 488 | 3 | Washington, MS - Sharkey, MS |
| 489 | 2 | Navarro, TX - Freestone, TX |
| 490 | 2 | Colorado, TX - Fayette, TX |
| 491 | 2 | Deaf Smith, TX - Parmer, TX |
| 492 | 5 | Midland (Midland), TX - Pecos, TX |
| 493 | 4 | Comanche (Lawton), OK - Kiowa, OK |
| 494 | 4 | Boone, AR - Carroll, AR |
| 495 | 3 | Denton (Denton), TX - Cooke, TX |
| 496 | 2 | Ouachita, AR - Dallas, AR |
| 497 | 2 | Stephens, OK - Jefferson, OK |
| 498 | 2 | Alcorn, MS - Tishomingo, MS |
| 499 | 4 | Crittenden (West Memphis), AR - St. Francis, AR |
| 500 | 3 | St. Tammany (Slidell), LA - Washington, LA |
| 501 | 2 | Madison, TX - Leon, TX |
| 502 | 3 | Grenada, MS - Montgomery, MS |
| 503 | 3 | Nolan, TX - Mitchell, TX |
| 504 | 2 | Lawrence, MS - Jefferson Davis, MS |
| 505 | 3 | Brazoria (Lake Jackson), TX - Wharton, TX |
| 506 | 7 | Kerr, TX - Gillespie, TX |
| 507 | 2 | Erath, TX - Comanche, TX |
| 508 | 3 | Lea, NM - Andrews, TX |
| 509 | 3 | Cherokee, TX - Anderson, TX |
| 510 | 2 | Hays (San Marcos), TX - Caldwell, TX |
| 511 | 2 | Lincoln, MS - Copiah, MS |
| 512 | 3 | Childress, TX - Hall, TX |
| 513 | 2 | Bee, TX - Karnes, TX |
| 514 | 2 | Terry, TX - Yoakum, TX |
| 515 | 2 | Kay (Ponca City), OK - Osage, OK |
| 516 | 3 | Val Verde, TX - Maverick, TX |
| 517 | 1 | Comal (New Braunfels), TX |
| 518 | 2 | Howard, TX - Glasscock, TX |
| 519 | 1 | Scurry, TX |
| 520 | 2 | Cameron (Brownsville), TX - Willacy, TX |
| 521 | 1 | Jackson, AR |
| 522 | 1 | Johnson, AR |
| 523 | 1 | Claiborne, LA |
| 524 | 1 | Collingsworth, TX |
| 525 | 1 | Wilkinson, MS |
| 526 | 3 | Brewster, TX - Jeff Davis, TX |
| 527 | 2 | Arkansas, AR - Monroe, AR |
| 528 | 1 | St. Mary, LA |
| 529 | 2 | Okmulgee, OK - Okfuskee, OK |
| 530 | 1 | Winn, LA |
| 531 | 1 | Dimmit, TX |
| 532 | 1 | Galveston (Galveston), TX |
| 533 | 1 | Yazoo, MS |
| 534 | 1 | Polk, AR |
| 535 | 1 | Beaver, OK |
| 536 | 1 | Uvalde, TX |
| 537 | 1 | Phillips, AR |
| 538 | 3 | Webb (Laredo), TX - Jim Hogg, TX |
| 539 | 5 | Jasper (Joplin), MO - Newton, MO |
| 540 | 9 | Hennepin (Minneapolis), MN - Anoka, MN |
| 541 | 8 | St. Louis, MO - St. Louis city, MO |
| 542 | 9 | Douglas (Omaha), NE - Dodge, NE |
| 543 | 9 | Burleigh (Bismarck), ND - McLean, ND |
| 544 | 11 | Minnehaha (Sioux Falls), SD - Lake, SD |
| 545 | 8 | Linn (Cedar Rapids), IA - Johnson, IA |
| 546 | 11 | Polk (Des Moines), IA - Marion, IA |
| 547 | 13 | Cass (Fargo), ND - Wilkin, MN |
| 548 | 10 | Jackson (Kansas City), MO - Clay, MO |
| 549 | 15 | Greene (Springfield), MO - Barry, MO |
| 550 | 6 | Ward, ND - Bottineau, ND |
| 551 | 5 | Ford, KS - Clark, KS |
| 552 | 8 | Olmsted (Rochester), MN - Winona, MN |
| 553 | 7 | Boone (Columbia), MO - Randolph, MO |
| 554 | 9 | Shawnee (Topeka), KS - Riley, KS |
| 555 | 5 | Hall, NE - Hamilton, NE |

| HSA number | Number of counties in HSA | HSA name |
|---|---|---|
| 556 | 6 | Cerro Gordo, IA - Kossuth, IA |
| 557 | 6 | Black Hawk (Waterloo), IA - Fayette, IA |
| 558 | 6 | Pennington (Rapid City), SD - Meade, SD |
| 559 | 4 | Holt, NE - Brown, NE |
| 560 | 9 | Woodbury (Sioux City), IA - Buena Vista, IA |
| 561 | 6 | Lancaster (Lincoln), NE - Gage, NE |
| 562 | 3 | Baca, CO - Grant, KS |
| 563 | 14 | Cape Girardeau, MO - Butler, MO |
| 564 | 4 | Adams, NE - Nuckolls, NE |
| 565 | 6 | Ellis, KS - Graham, KS |
| 566 | 6 | Adair, MO - Scotland, MO |
| 567 | 4 | Lyon, KS - Greenwood, KS |
| 568 | 5 | Codington, SD - Grant, SD |
| 569 | 4 | Saline, KS - Ellsworth, KS |
| 570 | 7 | Buffalo, NE - Dawson, NE |
| 571 | 7 | Craighead, AR - Greene, AR |
| 572 | 7 | Brown, SD - Day, SD |
| 573 | 4 | Blue Earth, MN - Watonwan, MN |
| 574 | 8 | Independence, AR - Howell, MO |
| 575 | 6 | Finney, KS - Scott, KS |
| 576 | 6 | Sedgwick (Wichita), KS - Harvey, KS |
| 577 | 5 | Madison, NE - Antelope, NE |
| 578 | 6 | Yankton, SD - Bon Homme, SD |
| 579 | 3 | Williams, ND - Divide, ND |
| 580 | 8 | Scotts Bluff, NE - Goshen, WY |
| 581 | 8 | Cole, MO - Callaway, MO |
| 582 | 2 | Otter Tail, MN - Grant, MN |
| 583 | 4 | Barton, KS - Rush, KS |
| 584 | 6 | Grand Forks (Grand Forks), ND - Polk, MN |
| 585 | 3 | Webster, IA - Humboldt, IA |
| 586 | 3 | Lawrence, SD - Campbell, WY |
| 587 | 4 | Seward, KS - Texas, OK |
| 588 | 5 | Stearns (St. Cloud), MN - Morrison, MN |
| 589 | 6 | Wapello, IA - Mahaska, IA |
| 590 | 3 | Big Stone, MN - Roberts, SD |
| 591 | 8 | Buchanan (St. Joseph), MO - Nodaway, MO |
| 592 | 5 | Kandiyohi, MN - Yellow Medicine, MN |
| 593 | 6 | Lincoln, NE - Perkins, NE |
| 594 | 8 | Custer, NE - Valley, NE |
| 595 | 5 | Gregory, SD - Tripp, SD |
| 596 | 6 | Pottawattamie (Council Bluffs), IA - Shelby, IA |
| 597 | 2 | Beltrami, MN - Clearwater, MN |
| 598 | 3 | Reno, KS - Stafford, KS |
| 599 | 3 | St. Charles (St. Charles), MO - Lincoln, MO |
| 600 | 4 | Beadle, SD - Hand, SD |
| 601 | 4 | Labette, KS - Allen, KS |
| 602 | 3 | Brown, MN - Redwood, MN |
| 603 | 3 | Mille Lacs, MN - Isanti (Cambridge), MN |
| 604 | 4 | Pennington, MN - Kittson, MN |
| 605 | 4 | Stark, ND - Golden Valley, ND |
| 606 | 5 | Story, IA - Hamilton, IA |
| 607 | 3 | Henry, MO - St. Clair, MO |
| 608 | 3 | Douglas, MN - Stevens, MN |
| 609 | 2 | Lyon, MN - Lincoln, MN |
| 610 | 2 | Brookings, SD - Kingsbury, SD |
| 611 | 2 | York, NE - Polk, NE |
| 612 | 5 | Crow Wing, MN - Wadena, MN |
| 613 | 4 | Red Willow, NE - Decatur, KS |
| 614 | 2 | Mississippi, AR - Pemiscot, MO |
| 615 | 9 | Davison, SD - Charles Mix, SD |
| 616 | 3 | Phelps, NE - Furnas, NE |
| 617 | 2 | Greene, IA - Guthrie, IA |
| 618 | 3 | Pratt, KS - Kiowa, KS |
| 619 | 4 | Nobles, MN - Jackson, MN |
| 621 | 2 | Wyandotte (Kansas City), KS - Leavenworth, KS |
| 622 | 3 | Mitchell, KS - Osborne, KS |
| 623 | 5 | Dawes, NE - Sheridan, NE |
| 624 | 5 | Johnson (Overland Park), KS - Douglas, KS |
| 625 | 3 | Clay, IA - Dickinson, IA |
| 626 | 2 | Martin, MN - Emmet, IA |
| 627 | 4 | Phelps, MO - Dent, MO |
| 628 | 2 | Richardson, NE - Pawnee, NE |
| 629 | 6 | Hughes, SD - Haakon, SD |
| 630 | 3 | Crawford, KS - Bourbon, KS |
| 631 | 2 | Roseau, MN - Lake of the Woods, MN |
| 632 | 3 | Stutsman, ND - Foster, ND |
| 633 | 3 | Carroll, IA - Calhoun, IA |
| 634 | 2 | Floyd, IA - Chickasaw, IA |
| 635 | 2 | Marshall, KS - Washington, KS |
| 636 | 2 | Rawlins, KS - Cheyenne, KS |
| 637 | 3 | Phillips, KS - Smith, KS |
| 638 | 3 | Pierce, ND - Rolette, ND |
| 639 | 2 | Vernon, MO - Cedar, MO |
| 640 | 6 | Adams, ND - Bowman, ND |
| 641 | 2 | Scott (Davenport), IA - Muscatine, IA |
| 642 | 2 | Cloud, KS - Republic, KS |
| 643 | 2 | Greeley, KS - Wichita, KS |
| 644 | 3 | Page, IA - Fremont, IA |
| 645 | 2 | Lucas, IA - Wayne, IA |
| 646 | 2 | Freeborn, MN - Faribault, MN |
| 647 | 2 | Montgomery, IA - Adams, IA |
| 648 | 5 | Walworth, SD - Potter, SD |
| 649 | 2 | Appanoose, IA - Davis, IA |
| 650 | 3 | Dickinson, KS - Geary, KS |
| 651 | 3 | Platte, NE - Nance, NE |
| 652 | 2 | Obrien, IA - Osceola, IA |
| 654 | 3 | Chase, NE - Dundy, NE |
| 655 | 3 | Ramsey, ND - Eddy, ND |
| 656 | 4 | Pettis, MO - Saline, MO |
| 657 | 2 | Livingston, MO - Carroll, MO |
| 658 | 2 | Fillmore, NE - Thayer, NE |
| 659 | 3 | Thomas, KS - Sherman, KS |
| 660 | 2 | Otoe, NE - Johnson, NE |
| 661 | 2 | Harper, KS - Kingman, KS |
| 662 | 1 | Clay, KS |
| 663 | 1 | Madison, MO |
| 664 | 1 | Stevens, KS |
| 665 | 1 | Mitchell, IA |
| 666 | 3 | Audrain, MO - Monroe, MO |
| 667 | 1 | Russell, KS |
| 668 | 1 | Cherry, NE |
| 669 | 1 | Barber, KS |
| 670 | 1 | Grant, ND |
| 671 | 1 | Atchison, KS |

| HSA number | Number of counties in HSA | HSA name |
|---|---|---|
| 672 | 1 | Sioux, IA |
| 673 | 1 | Linn, MO |
| 674 | 1 | McPherson, KS |
| 675 | 1 | Wilson, KS |
| 676 | 1 | Taney, MO |
| 678 | 2 | Atchison, MO - Holt, MO |
| 679 | 2 | Marshall, IA - Tama, IA |
| 680 | 2 | Dickey, ND - La Moure, ND |
| 681 | 1 | Crawford, IA |
| 682 | 1 | Ness, KS |
| 683 | 2 | Grundy, MO - Mercer, MO |
| 684 | 2 | McIntosh, ND - Logan, ND |
| 685 | 1 | Camden, MO |
| 686 | 1 | Poweshiek, IA |
| 687 | 1 | Nemaha, NE |
| 688 | 11 | Denver (Denver), CO - Jefferson, CO |
| 689 | 8 | Multnomah (Portland), OR - Clackamas, OR |
| 690 | 3 | Yuba, CA - Sutter (Yuba City), CA |
| 691 | 8 | Yellowstone (Billings), MT - Carbon, MT |
| 692 | 7 | Cascade (Great Falls), MT - Glacier, MT |
| 693 | 5 | Bernalillo (Albuquerque), NM - Valencia, NM |
| 694 | 6 | Nez Perce, ID - Asotin, WA |
| 695 | 4 | Twin Falls, ID - Jerome, ID |
| 696 | 5 | Bannock, ID - Bingham, ID |
| 697 | 3 | Butte (Chico), CA - Tehama, CA |
| 698 | 6 | Spokane (Spokane), WA - Stevens, WA |
| 699 | 5 | Maricopa (Phoenix), AZ - Yavapai, AZ |
| 700 | 5 | Pima (Tucson), AZ - Cochise, AZ |
| 701 | 10 | Washoe (Reno), NV- Ormsby, NV |
| 702 | 2 | Benton (Kennewick), WA - Franklin, WA |
| 703 | 6 | Utah (Provo), UT - Sevier, UT |
| 704 | 4 | Pueblo (Pueblo), CO - Colfax, NM |
| 705 | 3 | Marion (Salem), OR - Yamhill, OR |
| 707 | 8 | Clark (Las Vegas), NV - Washington, UT |
| 708 | 6 | Salt Lake (Salt Lake City), UT - Uintah, UT |
| 709 | 4 | Sacramento (Sacramento), CA - Placer, CA |
| 710 | 3 | Shasta (Redding), CA - Modoc, CA |
| 711 | 6 | Mesa, CO - Garfield, CO |
| 712 | 4 | Hill, MT - Phillips, MT |
| 713 | 6 | Missoula, MT - Ravalli, MT |
| 714 | 6 | Custer, MT - Fallon, MT |
| 715 | 3 | Cache, UT - Franklin, ID |
| 716 | 7 | Ada (Boise), ID - Canyon, ID |
| 717 | 4 | Walla Walla, WA - Umatilla, OR |
| 718 | 3 | Fresno (Fresno), CA - Kings, CA |
| 719 | 5 | Deschutes, OR - Crook, OR |
| 720 | 3 | Elko, NV - Lander, NV |
| 721 | 3 | Lewis and Clark, MT - Broadwater, MT |
| 722 | 8 | Bonneville, ID - Madison, ID |
| 723 | 2 | Los Angeles (Los Angeles), CA - Orange, CA |
| 724 | 4 | Santa Fe (Santa Fe), NM - Rio Arriba, NM |
| 725 | 4 | Curry, NM - Quay, NM |
| 726 | 2 | Natrona (Casper), WY - Converse, WY |
| 727 | 2 | Linn, OR - Benton, OR |
| 728 | 2 | Flathead, MT - Lincoln, MT |
| 729 | 4 | Malheur, OR - Washington, ID |
| 730 | 2 | Cassia, ID - Minidoka, ID |
| 731 | 6 | Alamosa, CO - Rio Grande, CO |
| 732 | 3 | Dona Ana (Las Cruces), NM - Luna, NM |
| 733 | 2 | Sheridan, MT - Daniels, MT |
| 734 | 5 | Kootenai, ID - Bonner, ID |
| 735 | 2 | Moffat, CO - Routt, CO |
| 736 | 6 | King (Seattle), WA - Snohomish, WA |
| 737 | 4 | Stanislaus (Modesto), CA - Merced, CA |
| 738 | 3 | Coos, OR - Del Norte, CA |
| 739 | 2 | Yakima (Yakima), WA - Kittitas, WA |
| 740 | 8 | San Juan, NM - La Plata, CO |
| 741 | 4 | Laramie (Cheyenne), WY - Cheyenne, NE |
| 742 | 3 | Silver Bow, MT - Deer Lodge, MT |
| 743 | 2 | Klamath, OR - Lake, OR |
| 744 | 5 | Weber (Ogden), UT - Davis, UT |
| 745 | 5 | Otero, CO - Prowers, CO |
| 746 | 3 | Solano (Vallejo), CA - Napa, CA |
| 747 | 4 | Chelan, WA - Okanogan, WA |
| 748 | 6 | Wasco, OR - Hood River, OR |
| 749 | 2 | Park, WY - Big Horn, WY |
| 750 | 3 | San Joaquin (Stockton), CA - Amador, CA |
| 751 | 3 | Santa Clara (San Jose), CA - Monterey, CA |
| 752 | 3 | Jackson (Medford), OR - Josephine, OR |
| 753 | 2 | Nevada, CA - Sierra, CA |
| 754 | 5 | El Paso (Colorado Springs), CO - Kit Carson, CO |
| 755 | 2 | Iron, UT - Beaver, UT |
| 756 | 2 | Park, MT - Sweet Grass, MT |
| 757 | 2 | San Francisco (San Francisco), CA - San Mateo, CA |
| 758 | 5 | Thurston (Olympia), WA - Lewis, WA |
| 759 | 3 | Union, OR - Baker, OR |
| 760 | 4 | Weld (Greeley), CO - Morgan, CO |
| 761 | 6 | Delta, CO - Montrose, CO |
| 763 | 3 | Logan, CO - Phillips, CO |
| 764 | 2 | Sonoma (Santa Rosa), CA - Marin, CA |
| 765 | 2 | McKinley, NM - Apache, AZ |
| 766 | 2 | Alameda (Oakland), CA - Contra Costa, CA |
| 767 | 4 | Richland, MT - Dawson, MT |
| 768 | 2 | San Bernardino, CA - Riverside (Riverside), CA |
| 769 | 2 | Otero, NM - Lincoln, NM |
| 770 | 2 | Sheridan, WY - Johnson, WY |
| 771 | 3 | Albany, WY - Carbon, WY |
| 772 | 2 | Chaves, NM - Eddy, NM |
| 773 | 2 | Gallatin, MT - Madison, MT |
| 774 | 2 | San Diego (San Diego), CA - Imperial, CA |
| 775 | 3 | Teton, WY - Lincoln, WY |
| 777 | 3 | Fremont, WY - Hot Springs, WY |
| 778 | 2 | Meagher, MT - Wheatland, MT |
| 779 | 2 | Roosevelt, MT - Valley, MT |
| 780 | 2 | Plumas, CA - Lassen, CA |
| 781 | 2 | Santa Barbara (Santa Barbara), CA - San Luis Obispo, CA |
| 782 | 2 | Lane (Eugene), OR - Douglas, OR |
| 783 | 2 | Lincoln, OR - Tillamook, OR |
| 784 | 2 | Latah, ID - Whitman, WA |

| HSA number | Number of counties in HSA | HSA name | HSA number | Number of counties in HSA | HSA name |
|---|---|---|---|---|---|
| 785 | 2 | Clallam, WA - Jefferson, WA | 807 | 1 | Kern (Bakersfield), CA |
| 786 | 2 | Chaffee, CO - Lake, CO | 808 | 2 | Blaine, ID - Camas, ID |
| 787 | 1 | Yuma (Yuma), AZ | 809 | 2 | Carbon, UT - Emery, UT |
| 788 | 1 | Powell, MT | 810 | 2 | Fergus, MT - Petroleum, MT |
| 789 | 1 | Tulare (Visalia), CA | 811 | 1 | Mendocino, CA |
| 790 | 1 | Ventura (Oxnard), CA | 812 | 2 | Fremont, CO - Custer, CO |
| 792 | 1 | Uinta, WY | 813 | 1 | Lemhi, ID |
| 793 | 3 | Grant, NM - Catron, NM | 814 | 1 | Union, NM |
| 794 | 1 | Pierce (Tacoma), WA | 815 | 1 | Whatcom (Bellingham), WA |
| 795 | 1 | Boulder (Boulder), CO | 816 | 2 | Inyo, CA - Mono, CA |
| 796 | 1 | Larimer (Fort Collins), CO | 817 | 3 | Ketchikan Gateway, AK - Wrangell - Petersburg, AK |
| 797 | 1 | Platte, WY | 818 | 4 | Juneau, AK - Sitka, AK |
| 799 | 2 | Sweetwater, WY - Daggett, UT | 819 | 3 | Fairbanks North Star, AK - Southeast Fairbanks, AK |
| 800 | 1 | Humboldt, CA | 820 | 15 | Anchorage (Anchorage), AK - Kenai Peninsula, AK |
| 801 | 4 | San Miguel, NM - Guadalupe, NM | | | |
| 802 | 1 | Santa Cruz (Santa Cruz), CA | 821 | 3 | Honolulu (Honolulu), HI - Maui, HI |
| 803 | 1 | Mohave, AZ | 822 | 1 | Kauai, HI |
| 804 | 1 | Weston, WY | 823 | 1 | Hawaii, HI |
| 805 | 1 | White Pine, NV | | | |
| 806 | 1 | Grant, OR | | | |

# Appendix II. Statistical Modeling

Traditionally, the variance for an age-adjusted death rate is computed as a weighted average of age-specific binomial variances (49). However, this estimator has been shown to often underestimate (127) and occasionally overestimate (128) the true variance of the rate. Empirical Bayes methods have been proposed to "stabilize" rates with large variances (129, 130), but these methods tend to overshrink the individual rates to some overall rate, possibly masking interesting spatial patterns (131). Mixed effects regression models were used to improve the variance estimates for the rates, and to provide predicted rates by age and region, estimates not available except from a model-based procedure. This appendix provides the technical details of the models used to produce the maps and graphs in this atlas.

Information from certificates of all deaths that occurred during 1988–92 was summarized to produce stratified numbers of deaths by cause of death (table 1), sex, race (see "Data sources" section), age (0–4, 5–14, 25–34 through 75–84, and 85 years and over), and HSA (31) for analysis. Corresponding person years at risk were computed by multiplying the stratified 1990 Census population by 5. Thus, rates presented in this atlas may be interpreted as "average annual rates" over the 5-year period.

**Notation.** Because separate analyses were conducted for each cause, sex, and race combination, subscripts for these factors are suppressed in this section. For each of these analyses, let

$d_{ij}$ = number of deaths in HSA $i$, age group $j$,
$n_{ij}$ = the corresponding population at risk.

Because deaths are rare relative to the large populations at risk, we may assume that

$$d_{ij} \sim \text{Poisson}(n_{ij}\lambda_{ij}) \qquad (1)$$

where $\lambda_{ij}$ is the age-specific death rate for age $j$ $(j=1,...,J)$, HSA $i$ $(i=1,...,I)$. Then the maximum likelihood estimator of $\lambda_{ij}$ is $\hat{\lambda}_{ij} = r_{ij} = d_{ij} / n_{ij}$, the observed age-specific rate for HSA $i$ and age $j$. For the atlas data, $J$=10 and $I$=798 (data for Alaska and Hawaii were not modeled).

**Age-adjusted rates.** The observed age-adjusted rate for HSA $i$ is computed using the direct method as a weighted average of the age-specific rates for HSA $i$:

$$R_i = \sum_{j=1}^{J} r_{ij}c_j = \hat{\lambda}_i'C \qquad (2)$$

with expected value $E(R_i) = \lambda_i'C$, where $\lambda_i = (\lambda_{i1}, \lambda_{i2},...,\lambda_{iJ})'$, and $C$ is a vector of weights consisting of age-specific proportions of the standard population $\left(\sum c_j = 1\right)$. All rates in this atlas have been adjusted to the U.S. standard million population using the age groups and weights in table 2.

**Dispersion of rates.** In order to make inferences about either the age-specific ($r_{ij}$) or age-adjusted rates ($R_i$), accurate estimates of their variances are needed. In the absence of repeated data samples, the analyst needs to rely on either a computationally intensive nonparametric method, such as Gibb's sampling, or a theoretically justifiable variance estimator. A common solution is to assume homogeneity of rates across all geographic areas, that is, $\lambda_{ij} = \lambda_j$ for all $i$. This is not a valid assumption for U.S. mortality data (131), and leads to the appearance of overdispersion of rates.

Potential sources of overdispersion in these data are heterogeneity of the underlying rates across geographic areas, exclusion of important explanatory variables from the rate model, and correlations among the age-adjusted rates. For example, rates may be spatially correlated because of unmeasured environmental, lifestyle, or other regional effects. To account for possible overdispersion, the distributional assumptions about $d_{ij}$ (equation 1) were generalized to:

$$\begin{aligned} E(d_{ij}) &= n_{ij}\lambda_{ij} \\ \text{Var}(d_{ij}) &= \phi n_{ij}\lambda_{ij} \end{aligned} \qquad (3)$$

Then asymptotically, $\text{Var}(r_{ij}) = \phi\lambda_{ij} / n_{ij}$ and

$$\text{Var}(R_i) = \phi \sum_{j=1}^{J} c_j^2 \frac{\hat{\lambda}_{ij}}{n_{ij}} = \phi C' \text{Diag}\left(\frac{\hat{\lambda}_{ij}}{n_{ij}}\right)C \qquad (4a)$$

Because death is a rare event, this Poisson-derived variance is well approximated by the binomial form of the variance:

$$\text{Var}(R_i) \approx \phi C' \text{Diag}\left(\frac{\hat{\lambda}_{ij}\left(1-\hat{\lambda}_{ij}\right)}{n_{ij}}\right)C \qquad (4b)$$

which is just the traditional variance for an age-adjusted rate (49) multiplied by the dispersion factor $\phi$.

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**Generalized linear model.** In order to share information across areas to achieve stability of parameter estimates, the place- and age-specific rates were modeled as a function of age. That is,

$$\ln(r_{ij}) = f(a_j, \beta_i) + \varepsilon_{ij} \qquad (5)$$

where $a_j$ is the midpoint of age group $j$ rescaled by dividing by 10 (that is, $a_j = 0.25, 1, 2,..., 9$), and $\beta_i$ is the vector of parameters to be estimated; 0.000001 was added to each $r_{ij}$ to avoid taking logarithms of zero. Because of the irregularity of the dependence of death rates on age for external causes of death, it was necessary to use cubic and linear spline forms for $f(a_j, \beta_i)$. Specifically,

$$f(a_j, \beta_i) = \ln \lambda_{ij} = X_j \beta_i \qquad (6)$$

For the linear model

$$X_j = \left(1, a_j, \delta_1(a_j - k_1), \delta_2(a_j - k_2), \delta_3(a_j - k_3)\right) \qquad (7a)$$

and for the cubic model

$$X_j = \left(1, a_j, a_j^2, a_j^3, \delta_1(a_j - k_1)^3\right) \qquad (7b)$$

where $\delta_m = 1$ if $a_j > k_m$, 0 otherwise, and $\{k_1, k_2, k_3\}$ is the set of spline knots predetermined as optimal for U.S. age-specific rates for each cause, race, and sex. Thus this model reduced the number of parameters to be estimated from 10 $(\lambda_i)$ to 5 $(\beta_i)$ for each HSA.

**Random effects.** Further reduction in the parameter space and stability of estimates were achieved by allowing the intercept and, for whites, initial slope parameter estimates to vary by HSA within region in a hierarchical random effects model. That is,

$$\beta_i = \beta_k + b_i \text{ for HSA } i \in \text{region } k$$

$$b_i = \begin{cases} (b_{0i}, b_{1i}, 0, 0, 0)' & \text{for whites} \\ (b_{0i}, 0, 0, 0, 0)' & \text{for blacks} \end{cases} \qquad (8)$$

$$\beta_k \text{ fixed and } b_i \sim N(0, D_k)$$

where $D_k$ is the covariance matrix for the random HSA effects. Because of computational constraints, all

regional effects were considered fixed, not themselves random effects within an overall U.S. effect. Predicted age-specific rates derived from these regional estimates, $e^{X_j' \hat{\beta}_k}$, are plotted along with their 95-percent confidence limits for each cause, race, and sex (see figure 1c). This model accommodates age-by-HSA interactions through the HSA random effects within region and age-by-region interactions through the individual fixed regional effects.

**Computational methods.** From equation 4a, it can be shown that asymptotically

$$\text{Var}\left(\ln(r_{ij})\right) \approx \phi/(n_{ij}\lambda_{ij}) \qquad (9)$$

Therefore, a generalized linear model analysis of $\ln(r_{ij})$ using inverse standard error weights of $(n_{ij}\lambda_{ij})^{1/2}$ will yield an estimate of the dispersion parameter $\phi$ directly as the residual variance:

$$\hat{\phi} = \sum_{i,j}\left[\ln(r_{ij}) - E\left(\ln(r_{ij})|\beta_i\right)\right]^2 \Big/ (IJ - p) \qquad (10)$$

where $p$ is the number of parameters estimated for the model.

An EM algorithm can be used to estimate the parameters, by iterating between computing the weights $(n_{ij}\lambda_{ij})^{1/2} = \left[E(d_{ij}|\lambda_{ij})\right]^{1/2}$ from each $\hat{\beta}_i$, and then recomputing $\hat{\beta}_i$ using these new weights. Initial weights were created by substituting $d_{ij}$ for $E(d_{ij}|\lambda_{ij})$ unless $d_{ij} < 3$, when an expected number of deaths was computed using marginal regional rates. Parameters were estimated by repeated applications of SAS PROC MIXED (132).

Analysis of sample data demonstrated convergence of the parameter estimates within five iterations. In fact, except for very sparsely populated areas, the results of the first PROC MIXED model using the initial weights were within 5 percent of the final rate estimates. Therefore, because of the computational difficulty of iterating the random effects model for each of the 72 cause-, race-, sex-specific datasets, the results of the initial iteration were used as input to the smoothing algorithm.

**Smoothing algorithm.** Predicted age-specific rates for each HSA were smoothed using a weighted headbanging algorithm (52), with weights equal to the inverse of the rates' estimated standard errors. For the sample data, this choice of weights caused rates for sparsely populated HSA's to be smoothed to

essentially the same relative values whether results of the first or last iteration were used. These smoothed, modeled age-specific rates were then mapped for each cause, race, and sex as an adjunct to the maps of age-adjusted rates (see figures 1d, 1e).

**Variance estimation.** An analysis of simulated data showed less than a 1-percent bias in estimating $\hat{\beta}_i$ using these methods, but a large bias in estimating $\phi$. Therefore, a robust sandwich estimator was used to compute the dispersion parameter (133):

$$\hat{\phi} = \sum_{i,j} \left. \frac{\left[ d_{ij} - \mathrm{E}\left( d_{ij} \mid \beta_i \right) \right]^2}{\mathrm{E}\left( d_{ij} \mid \beta_i \right)} \right/ (IJ - p) \qquad (11)$$

Observations with absolute standardized residuals more extreme than 5 were excluded from equation 11. This estimator was also proposed by McCullagh and Nelder (134) as a residual sum of squares estimator of dispersion.

Several forms of the random effects variance matrix $D_k$ were examined using PROC MIXED, several of which included spatial correlation among HSA's as a function of distance between population centroids. However, after accounting for broad spatial patterns through the fixed regional effects, the covariance parameters converged to zero. Similarly, examination of the residuals showed little remaining spatial autocorrelation. Thus the final models used for the atlas data included only diagonal variance matrices.

The robust dispersion estimate (equation 11) was used to adjust the traditional variance for each age-adjusted rate (as in equation 4b) for purposes of determining reliability (figure 1a) and significance (figure 1b) of the rates for mapping. When applied to simulated data, this method resulted in 94.5-percent coverage of the true rates by nominal 95-percent confidence intervals. Goodness-of-fit plots and statistics indicate that these methods fit the observed mortality data well (48).