West Nile virus in South Dakota: human epidemiology of the first 5 years, 2002 - 2006.

West Nile virus (WNV) is a mosquito-borne flavivirus first described in Uganda, East Africa, in 1937. Sixty-two years later the virus was first detected in North America during the summer of 1999 in New York City. Over the next three years WNV swarmed across North America, reaching South Dakota and the Rocky Mountains in 2002. By 2006 WNV had spread to all contiguous 48 States and was enzootic in most of North America. West Nile virus is expected to persist as a public health threat to South Dakota into the foreseeable future.

Although birds are the primary reservoir of WNV, humans are among the accidental mammalian hosts. Human infection is generally asymptomatic, but approximately 20% of human infection causes acute febrile illness (WN fever) and about 1% develop more severe neuroinvasive syndromes including meningitis, encephalitis and acute flaccid paralysis or poliomyelitis. Approximately 10% of WNV neuroinvasive cases are fatal. Since WNV disease is a relatively recent occurrence in the United States the long-term health sequelae of those infected are not yet well understood.

Acute clinical features of human WNV syndromes[(1)]

WNV syndrome	Acute clinical features	Case-fatality rate
WN fever	Abrupt onset of fever, headache, malaise, fatigue, anorexia, and nausea.	<1%
WN meningitis	Symptoms of WNF, plus meningismus (nuchal rigidity, photo- and phonophobia); cerebrospinal fluid with pleocytosis; WBC count generally !500 cells/mm^3	<1%
WN encephalitis	Symptoms of WNF, plus encephalopathy (altered mental status, lethargy), and/or focal neurologic signs (weakness, cranial nerve palsies); movement disorders, including tremor, parkinsonism, and ataxia, may be frequent	20%
WN poliomyelitis	Acute onset of limb weakness or paralysis; weakness is typically asymmetric and abrupt; involved limbs typically are flaccid and are flexic; respiratory muscles may be involved; WNP may occur in the absence of fever or other features suggestive of WNV infection	10% - 50%

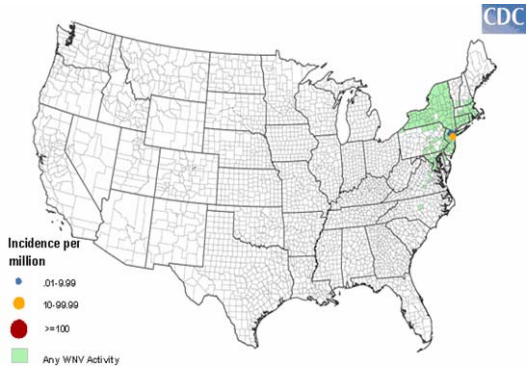
Since 1999 there have been 23,975 report cases of human WNV disease and 962 WNV-associated deaths in the United States. In South Dakota 1,469 human WNV disease, including 264 cases of WNV neuroinvasive disease and 20 WNV-associated deaths, have been reported since 2002 when the virus was first detected in this state. The peak outbreak year in South Dakota was 2003 when 1,039 human WNV cases and 14 deaths were reported. During the past 5 years there have also been 94 viremic blood donors, 2 cases of WNV transmission through blood transfusion[(2)], and 13 cases of pregnancy-associated WNV illness[(3)] reported in South Dakota.

WNV human neuroinvasive disease incidence, United States 1999-2006

(cases per million population) and any WNV activity

1999

2000



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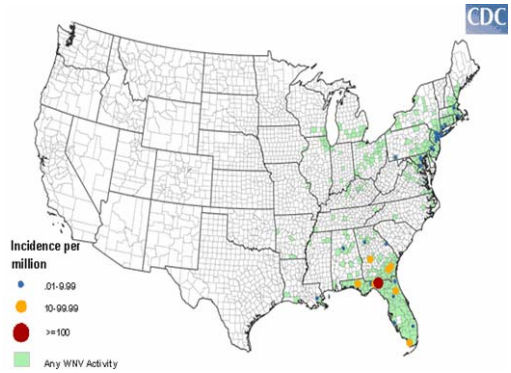

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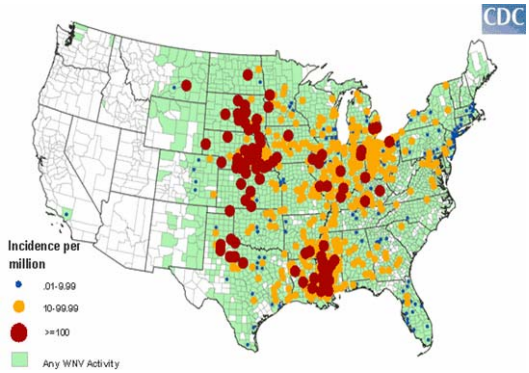

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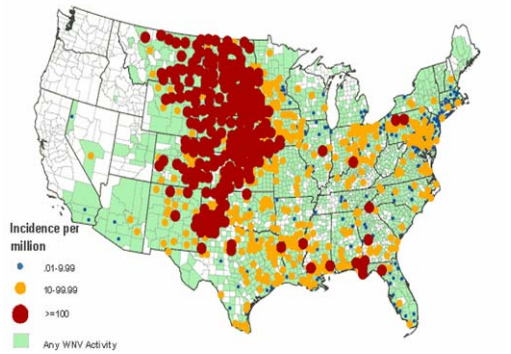

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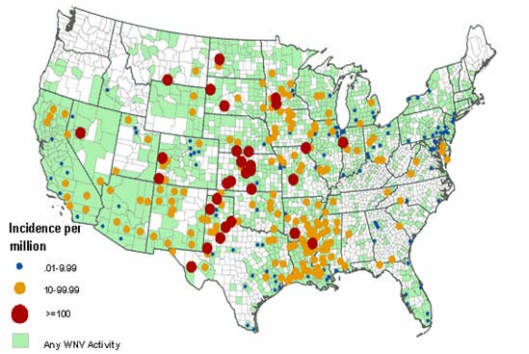

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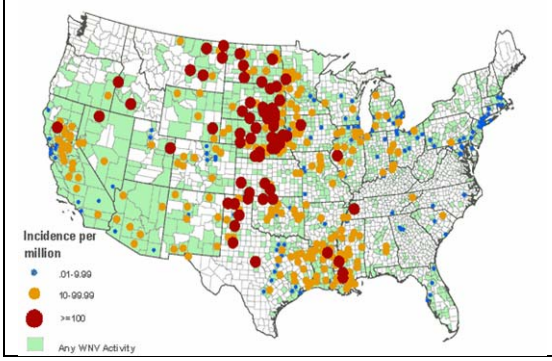
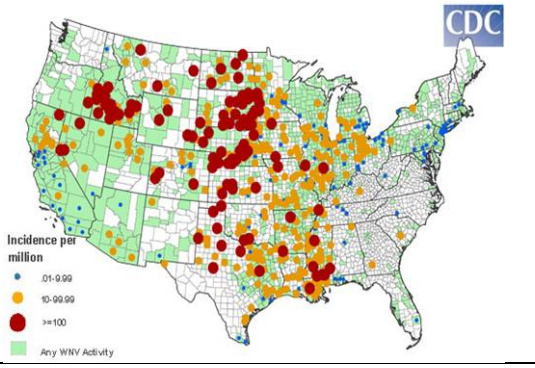


2006

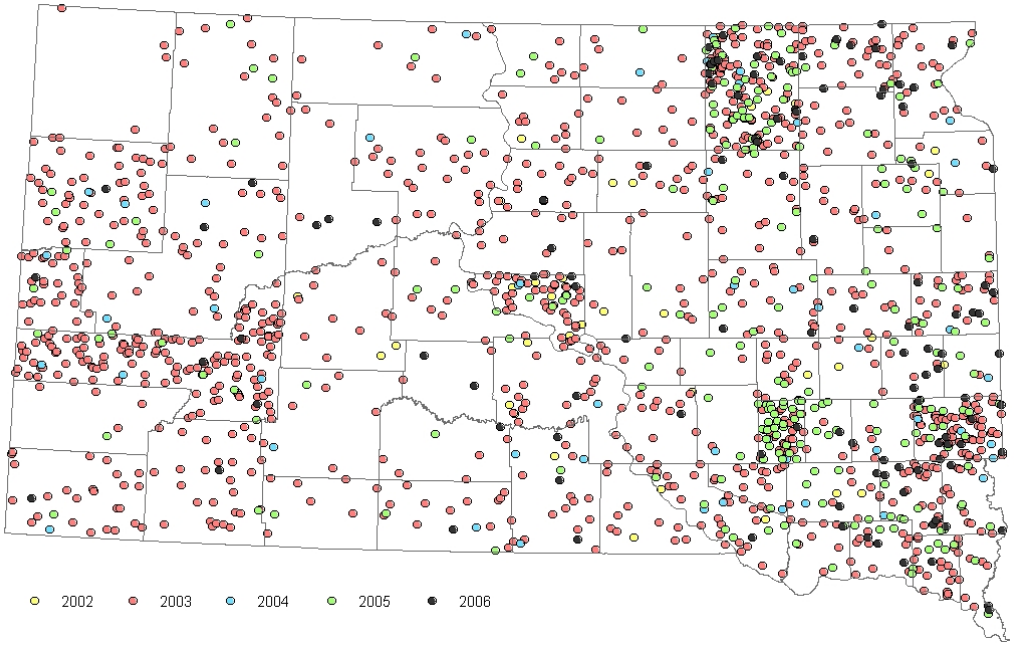


West Nile virus human cases, United States and South Dakota, 1999 - 2006									
United States	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total**
All human cases	62	21	66	4156	9862	2539	3000	4269	**23,975**
WNV fever	3	2	2	1160	6830	1269	1607	2616	**13,489**
WNV neuroinvasive	59	19	64	2946	2866	1142	1294	1459	**9849**
Viremic blood donors	SNA	SNA	SNA	SNA	818	224	417	361	**1,820**
Deaths	7	2	9	284	264	100	119	177	**962**
South Dakota									
All human cases	0	0	0	37	1039	51	229	113	**1,469**
WNV fever	0	0	0	23	868	45	194	75	**1,205**
WNV neuroinvasive	0	0	0	14	171	6	35	38	**264**
Viremic blood donors	SNA	SNA	SNA	SNA	60	3	19	12	**94**
Deaths	0	0	0	0	14	1	2	3	**20**

SNA: screening not available.

States in the upper Great Plains region of the United States have had the highest average annual incidence of WNV neuroinvasive illness. The top 10 highest incidence states include South Dakota 64.1 neuroinvasive cases per million population, Wyoming 56.8, Nebraska 44.1, North Dakota 41.3, Colorado 32.8, Idaho 28.5, Mississippi 24.5, Louisiana 22.1, Montana 21.4 and New Mexico 16.8.

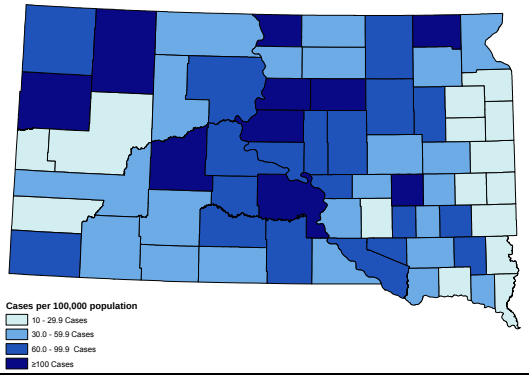
Distribution of human WNV cases, South Dakota, 2002-2006



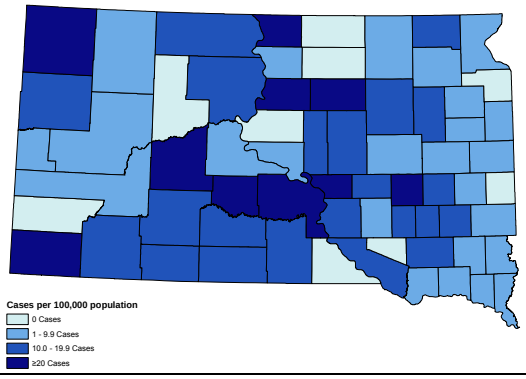
Random dot distribution with counties.

Human WNV cases have been reported in residents of all 66 South Dakota counties over the 5 years since WNV appeared, 2002-2006. Counties in the state's central zone generally have had higher incidence of WNV cases and neuroinvasive WNV cases.

All human West Nile disease incidence (average annual cases per 100,000 population), 2002-2006



Human West Nile neuroinvasive incidence (average annual cases per 100,000 population), 2002-2006



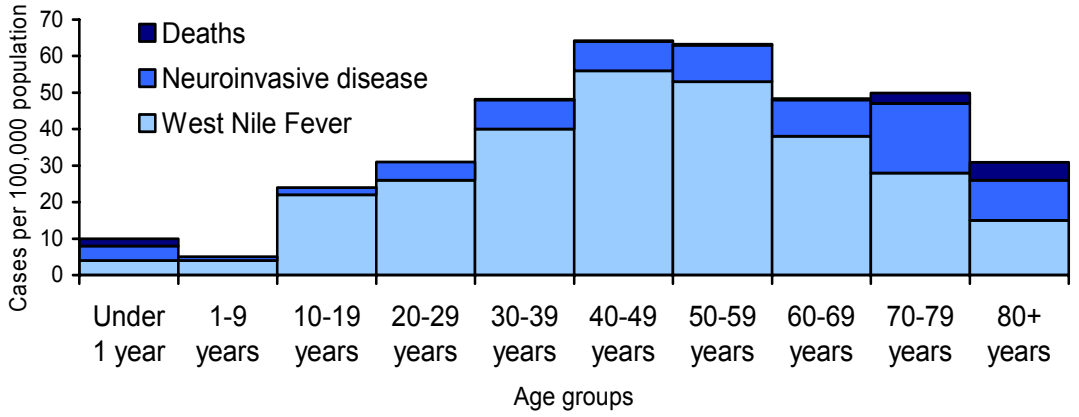
South Dakota males have been disproportionately affected by WNV. Of the 1,469 WNV cases reported 56% have been male, and notably 60% of neuroinvasive cases and 75% of deaths have been male. Ninety percent of WNV cases have been white race South Dakotans and 9% of cases have been American Indian. The more severe aspects of WNV had a greater race disparity with 17% of neuroinvasive cases and 15% of deaths were among American Indians.

Human WNV cases in South Dakota counties, 2002-2006

Aurora	4	Day	14	Jackson	8	Perkins	22
Beadle	26	Deuel	3	Jerauld	4	Potter	16
Bennett	8	Dewey	25	Jones	4	Roberts	25
BonHomme	11	Douglas	16	Kingsbury	16	Sanborn	16
Brookings	32	Edmunds	9	Lake	13	Shannon	29
Brown	159	Fall River	28	Lawrence	31	Spink	26
Brule	15	Faulk	13	Lincoln	20	Stanley	12
Buffalo	7	Grant	11	Lyman	23	Sully	9
Butte	54	Gregory	12	Marshall	32	Todd	16
Campbell	8	Haakon	12	McCook	10	Tripp	22
CharlesMix	38	Hamlin	6	McPherson	7	Turner	33
Clark	12	Hand	11	Meade	33	Union	9
Clay	26	Hanson	10	Mellette	7	Walworth	10
Codington	13	Harding	4	Miner	6	Yankton	18
Corson	9	Hughes	59	Minnehaha	86	Ziebach	7
Custer	5	Hutchinson	17	Moody	5	**TOTAL**	**1,469**
Davison	59	Hyde	6	Pennington	152		

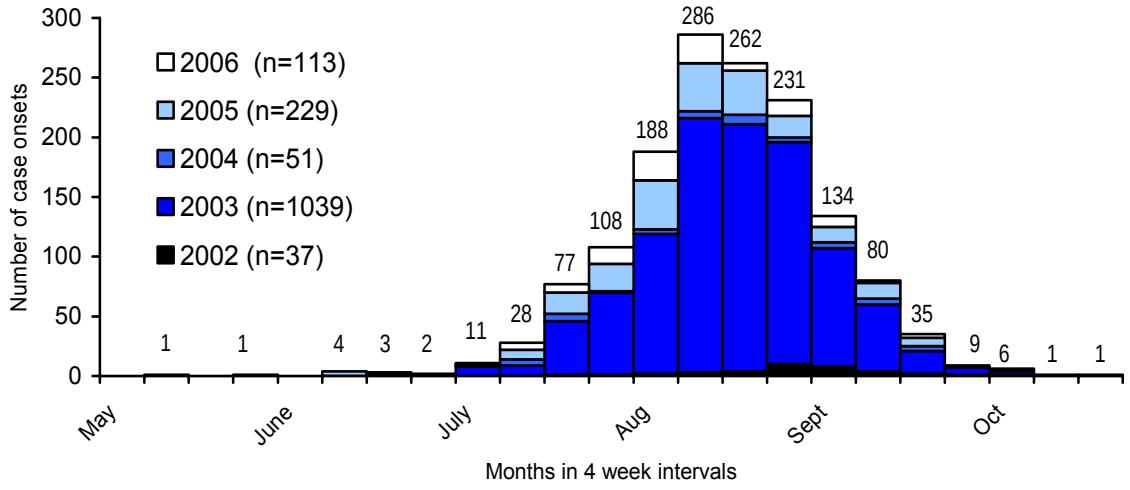
People in all age groups have been infected and sickened by WNV in South Dakota. The elderly are at highest risk of developing WN neuroinvasive disease. Overall 18% of cases (263/1467) developed WN neuroinvasive disease. This increases to 41% for people 70 years and older (65/157). Seventy-five percent of WNV-associated deaths were individuals over 70 years old (15/20).

Incidence of West Nile disease and death by age, South Dakota, 2002-2006 (mean annual incidence per 100,000 population)



West Nile disease is a seasonal illness in South Dakota associated with the ecology of the *Culex tarsalis* mosquito vector. Following the bite of a WNV infectious mosquito there is a 2 to 15 day incubation period before a person becomes ill. Although cases have occurred from May to October in South Dakota, 99% of case illness onsets were during July, August and September, with 66% of cases occurring during August. The second week of August is the peak risk period in South Dakota.

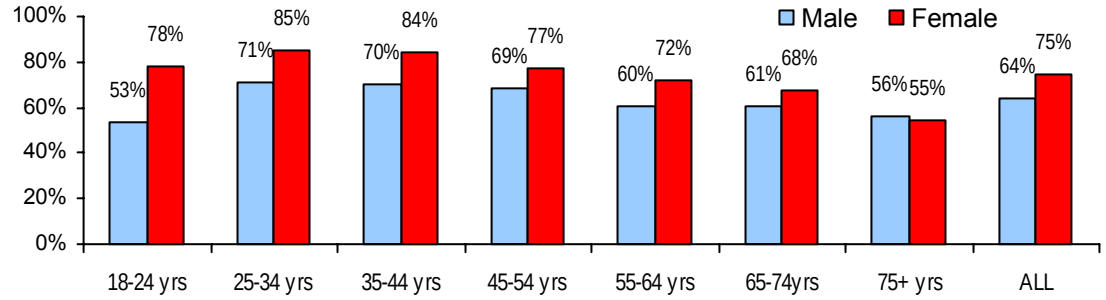
Human West Nile disease onset by month/week, South Dakota 2002-2006



As we enter the sixth season of WNV transmission in South Dakota, and the ninth year in the United States, a human vaccine is still not licensed, and specific treatment regimes are experimental. The lack of vaccine prevention and medical treatment leaves mosquito avoidance and mosquito control as the primary means of WNV prevention. Mosquito avoidance includes limiting time outdoors, screening doors and windows, bed nets, avoiding infested areas and discouraging mosquito bites by using repellents containing DEET, Picaridin or Oil of Lemon Eucalyptus. Mosquito contr1ol measures include elimination of standing water on personal and public property, and community-wide mosquito larval control and adulticide spraying.

Taking personal protective measures against WNV carrying mosquitoes is essential. Seventy percent of adult South Dakotans say they took any precautions against West Nile virus when asked by BRFSS surveyors (6,675 surveyed in SD Behavior Risk Factor Surveillance System 2005). The precautions against WNV included 66% of respondents using mosquito repellents, 49% checked their property for standing water mosquitoes breeding sites, 38% wore long pants and long sleeved shirts, and 27% stated they avoided outdoor activity. Women (75%) were more likely to protect themselves than men (64%). Although the elderly are at higher risk of severe WNV disease, the elderly were significantly less likely to protect themselves from mosquitoes: 77% of young adults 35-44 years old took precautions, whereas only 55% of elderly adults, 75 years and older, took precautions. The group most likely to take precautions is 25 to 34 year old women.

South Dakota adults who take any precautions against West Nile virus (BRFSS 2005)



It is concerning that individuals with underlying medical conditions making them more susceptible to severe WNV disease were less likely to use precautions. According to the 2005 BRFSS survey 62% of respondents with heart disease used precautions, whereas 70% of those without heart disease used precautions; 66% with hypertension took precautions, compared to 71% of those normal blood pressure; 67% of those with diabetes used precautions, whereas 70% of those without diabetes used precautions.

Over the past 5 years human WNV infection has caused extensive disease and death in South Dakota. This mosquito-borne virus is likely to persist as a public health threat into the foreseeable future.

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1. Sejvar, J., The long-term outcomes of human West Nile virus infection. 2007. Clinical Infectious Diseases, 44: 1617–1624.

2. Kightlinger, L., S. Brend, J Gorlin, M Kemperman, M. Kuehnert, J Sejvar, G. Campbell, E. Farnon, K. Ellingson. 2007. West Nile Virus transmission through blood transfusion – South Dakota, 2006. CDC, MMRW 56: 76-79.

3. O'Leary, D., S. Kuhn, K. Kniss, A. Hinckley, S. Rasmussen, W. Pape, L. Kightlinger, B. Beecham, T. Miller, D. Neitzel, S. Michaels, G. Campbell, R. Lanciotti, E. Hayes. Birth outcomes following West Nile Virus infection of pregnant women in the United States: 2003-2004. Pediatrics. 2006, 117: e537-45.

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