Burden of Stroke in the Pacific Northwest

August 2008

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The Northwest Regional Stroke Network is a collaboration of five states: Alaska, Idaho, Montana, Oregon and Washington. This report was guided by a five-state editorial board. It is posted online in pdf format: http://www.doh.wa.gov/cfh/NWR-Stroke-Network/default.htm

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Executive Summary

Stroke causes a substantial social and financial strain in the Pacific Northwest. *Burden of Stroke in the Pacific Northwest* presents a regional picture of the burden of stroke in the Pacific Northwest (NW region) including the percentage of the population with stroke or stroke risk factors, stroke hospitalizations, disability from stroke, and stroke deaths.

Stroke death rate higher in Pacific Northwest than national rate

The Northwest Regional Stroke Network (NWRSN) was created in 2007 with funding from the U.S. Centers for Disease Control and Prevention (CDC) to address common stroke challenges among these Pacific Northwest states: Alaska, Idaho, Montana, Oregon, and Washington. Among the region's challenges is the fact that the stroke death rate is higher in the NW region than the United States overall. Each state in the regional network is represented by clinical champions who provide direct care, state public health professionals, and members of the American Heart Association/American Stroke Association.

This report describes stroke burden on a regional level, a landmark achievement from both a national and regional perspective. Because each state produces its own burden report on stroke or cardiovascular disease, that information is not included in this report. The analysis for this report focused on adults aged 45 years and older in the NW region.

The major finding in this report was a higher overall stroke death rate in the NW region compared to the United States. This is despite the NW region having a lower prevalence of diagnosed risk factors and stroke hospitalizations. The NW region has a similar prevalence of stroke to the United States. Adults aged 45 years and older in the NW region have a lower prevalence of smoking, diagnosed high blood pressure, diagnosed diabetes, diagnosed heart disease, and diagnosed stroke risk factors compared to the rest of the United States. Further analysis is needed to confirm if the stroke death rate is indeed higher in the NW region, once undiagnosed risk factors or control of risk factors are taken into account.

An extensive review of literature found limited information about stroke in the NW region. Studies in Montana, Idaho and Wyoming have reported more barriers to stroke recognition and treatment in rural areas than in urban areas. In this report, hospitalization and death rates due to stroke were unrelated to urbanization. However, there was insufficient evidence to rule out rural geography as an explanation for the higher stroke death rate in the NW region. In this report, maps illustrate stroke hospitalization and death rates by county, and suggest that further research is needed to determine if there are true geographical differences between counties, especially those that border one another across state lines.

The results of this report show the continuing need for high quality stroke care at the state and regional level. This report highlights not only populations at higher risk, but also geographical areas of stroke occurrence, and the enormous financial burden of stroke in the region. The NWRSN's work will focus on areas of greatest need, using the results of this report and other methods to identify gaps in stroke care. This and other resources are available on the Northwest Regional Stroke Network Web site: http://www.doh.wa.gov/cfh/NWR-Stroke-Network/default.htm

Methodology & Framework

Purpose & Audience: This report is primarily a data report with an intended audience of stroke professionals, including neurologists, physicians, nurses, public health professionals and the American Heart Association/American Stroke Association.

Data sources: Data sources include the Behavioral Risk Factor Surveillance System (BRFSS); Centers for Disease Control and Prevention (CDC) Wonder death and population data; Death Certificate System data; Healthy People 2010; Hospitalization data; MetLife Market Survey of Nursing Home and Home Care Costs; Minimum Data Set Active Resident Information Report; National Hospitalization Discharge Survey; Population data; and Rural-Urban Commuting Area Code data. See Appendix A for comprehensive description of each data source

Methods: The Surveillance and Evaluation Committee, composed of state epidemiologists, a neurosciences data analyst, and neurologist (chair) gathered the most recent data that were available for this report. This committee has convened regularly through conference calls, email, and ad hoc communications. National BRFSS data were obtained from the CDC Web site. Hospitalization, death, and population count data from each state were collected with the aid of standardized protocols and spreadsheets. All other data were from the web. For consistency, all data were analyzed centrally by the lead epidemiologist with advice from the committee, epidemiologists, and a statistician at Washington State Department of Health.

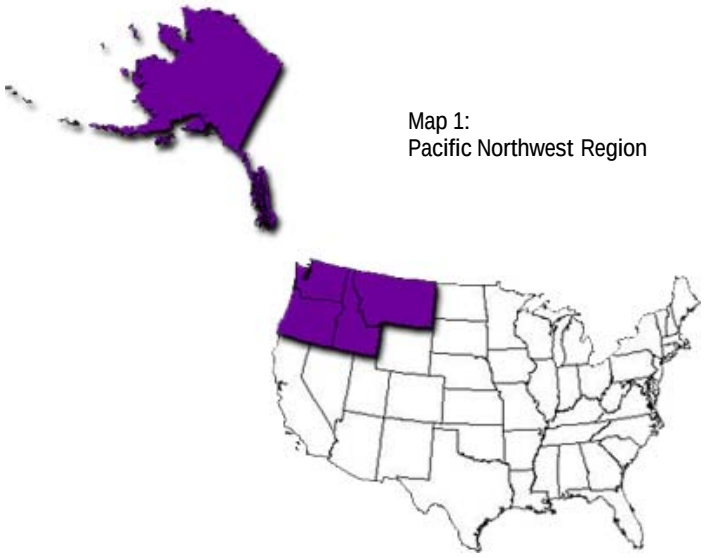
Data were analyzed primarily using Stata statistical software Version 10. Multiple years of data were combined for greater statistical power. Percentages and rates were adjusted for age, where possible. Data for the United States and NW region shown in graphs were of the United States and the NW region as a whole. However, statistical tests of the difference between the United States and NW region were conducted as the NW region versus the United States (minus the NW region) to maintain data independence. Similarly, the graphs showing data of the NW region and its constituent states present data for the NW region as a whole. However, statistical tests were constructed as the state versus the NW region (minus that state); for example, as Alaska versus the NW region minus Alaska. Small hospitalization and death data counts, and rates based on small counts, were suppressed to maintain confidentiality and reliability. Potential confounding factors were taken into account, where possible. Geographic Information Systems (GIS) maps of hospitalization and death counts and rates were created by the epidemiologist from Oregon. In this report, $p<0.001$ was used as a guideline and not a threshold together with sample size, magnitude of the difference between groups and other factors to assess if there were differences in outcomes between groups. See Appendix A for details.

Format: A regional stroke report for the NW region has not been created before. Given this is primarily a data report intended for stroke professionals, the format is primarily graphs involving percentages and rates, main results, topical overviews, and data sources and limitations. The five chapters are ordered by the progression of stroke occurrence: background and overview, people at risk for stroke, people with stroke, people disabled from stroke, and people who died from stroke – all in the NW region and adults aged 45 years and older. Finally, the overall interpretation and future considerations are presented in Chapter 6.

Chapter 1:
Background and purpose

Pacific Northwest Region

The Pacific Northwest region contains some of the most breathtaking landscapes and awe-inspiring scenery in the United States. It also has some of the most rugged terrain and harshest climates, presenting challenges to its inhabitants and creating unique barriers to stroke care.



Map 1:
Pacific Northwest Region

For the purposes of this report, the NW region refers to the states of Alaska, Idaho, Montana, Oregon, and Washington. This report describes the burden of stroke in the NW region, addressing areas of stroke occurrence, stroke hospitalizations, disability from stroke, and stroke death.

Certain regions of the country are well-known for having higher rates of stroke and higher rates of stroke mortality, like those seen in the "Stroke Belt" of the Southeast. However, a higher burden of stroke is also seen in other regions around the country, one of which is the NW region. One of the challenges for the NW region is that stroke death rates are above the national rate. Numerous studies and journals have addressed the barriers to stroke care, whether they are geographical, socioeconomic, accessibility, or lack of awareness about stroke risk factors.[1]

Figure 1:
Network structure

Since there is limited information in the literature specific to the NW region, this report addresses a unique need in both the region and country. The rural characteristics of the NW region will be addressed throughout the report. Based on census data, the states in the NW region have the following percents of population in rural areas: Alaska (34 percent), Idaho (34 percent), Montana (46 percent), Oregon (21 percent) and Washington (18 percent).

Rural areas are defined using RUCA coding (Rural-Urban Commuting Area) which is a tiered system based on census geography.

More information can be found in Appendix A or at http://www.doh.wa.gov/Data/Guidelines/RuralUrban.htm#suggested.

Existing studies consistently show unique barriers to quality stroke care in rural areas. A recent survey of rural hospitals in Idaho described the barriers to timely stroke care, including pre-hospital and in-hospital delays, along with limited resources and personnel surrounding acute stroke care.[2] Montana and northern Wyoming conducted a mailed survey in 2004 to better understand the available technology and resources for stroke treatment and evaluation. Results reinforced that rural and frontier areas have unique challenges in providing quality stroke care, and rural communities have challenges in receiving this care. Authors suggest that stroke network models could be helpful tools in improving stroke care in rural and frontier areas.[2, 3]

Stroke care inter-hospital network models are also recommended in numerous other studies.[4] These networks can exist within a state, involving local hospitals, and can also include multiple states, all with the purpose of enhanced stroke care and outcomes. It was for this very reason that the Northwest Regional Stroke Network (NWRSN) was formed in 2007 with funding from the CDC. The NWRSN is the most recent of five stroke networks in the country whose purpose is to use collaboration to address common stroke challenges. Information on the other stroke networks can be found at http://www.doh.wa.gov/cfh/NWR-Stroke-Network/other-networks.htm.

The NWRSN is composed of Alaska, Idaho, Montana, Oregon and Washington. Washington serves as the host state for the NWRSN, with a coordinator and epidemiologist at the Department of Health. Each state is equally represented by clinical champions who provide direct care, state public health professionals, and members of the American Heart Association/American Stroke Association. The NWRSN's mission is to facilitate, through collaboration, equal access to high quality stroke care throughout the NW region. More information on the NWRSN can be found at http://www.doh.wa.gov/cfh/NWR-Stroke-Network/default.htm

Purpose of Report

The purpose of this report is to present a regional picture of the burden of stroke, showing regional rates in comparison to the United States and/or individual states where available. This has not been accomplished before in the NW region. Each state included in this report has previously created a state-specific burden report on stroke and/or cardiovascular disease; therefore that information will not be presented again. For more in-depth information on each state, please visit the following Web site to access each state's individual burden report: http://www.doh.wa.gov/cfh/NWR-Stroke-Network/resources.htm. The information in this report will be used along with a regional needs assessment to guide decision-making around continuing quality stroke care in the NW region. In June 2008, a regional stroke strategic plan was developed incorporating data from this report, information from the regional needs assessment, and existing state-specific resources.

Understanding Stroke

Description

The term "stroke" is defined by the World Health Organization as "rapidly developed clinical signs of focal (or global) disturbance of cerebral function lasting more than 24 hours (unless interrupted by surgery or death), with no apparent cause other than a vascular origin: it includes patients presenting clinical signs and symptoms suggestive of subarachnoid hemorrhage, intracerebral hemorrhage or cerebral ischemic necrosis."[5] Without a proper blood supply, the affected brain cells die, causing symptoms that can vary greatly depending on the part of the brain that is injured by the stroke.

Stroke symptoms lasting less than 24 hours are defined to be a transient ischemic attack (TIA) and can be warning signs for a larger stroke. Since a TIA and stroke have the same symptoms, and to avoid delays in treatment of a stroke, TIA and stroke should be treated as an emergency and 911 should be called immediately. It is estimated that at least five million U.S. adults have been diagnosed with stroke, equivalent to two percent or more of the non-institutionalized adult population.[6, 7] Stroke is the leading cause of long-term disability in the United States and results in costs of $62.7 billion.[8]

Three main types of stroke exist: ischemic stroke, intraparenchymal hemorrhage (IPH) and subarachnoid hemorrhage (SAH). About 80 percent of all strokes are ischemic (due to the blockage of an artery, interrupting the blood supply to a portion of the brain), 15 percent of strokes are IPHs (due to a blood vessel bursting and bleeding into the substance of the brain), and approximately five percent are SAHs (due to a blood vessel bursting near the base of the brain causing bleeding into the membranes surrounding the brain). Tissue plasminogen activator (tPA) is a medicine approved by the FDA in 1996 which can be used for the acute treatment of ischemic stroke by breaking up the clot, restoring blood flow to the affected portion of brain, and reducing the risk of disability.

Importantly, "time is brain" and there is only a three-hour window from stroke symptom onset to when tPA can safely be used for the treatment of ischemic stroke. Recognizing the signs and symptoms of stroke, and getting to the hospital as soon as possible, is therefore an important public health priority.

Stroke Systems

The best stroke care can be given when appropriate stroke systems are in place. In 2005, the American Stroke Association created recommendations for the establishment of stroke systems of care, including the recommended key components of primary prevention, community education, notification and response of EMS, acute stroke treatment, sub-acute stroke treatment, secondary prevention, rehabilitation, and continuous quality improvement activities. A systems approach has been proven to be both cost-effective and improve treatment time. In addition to accredited clinical stroke centers, stroke network models have been shown to improve the quality of stroke care, improve outcomes, be cost-effective, and reduce disparities. Understanding the capacity and needs within states and between states with similar geography and demography is essential in meeting those needs in a systemic manner. Additionally, the Brain Attack Coalition created recommendations for the designation of Primary Stroke Centers and Comprehensive Stroke Centers.[9,10]

Healthy People 2010 Objectives

Several *Healthy People 2010* goals address stroke. The national *Healthy People 2010* Midcourse review goal is to decrease stroke mortality to 48 deaths per 100,000 population.[11] Other *Healthy People 2010* goals related to stroke risk factors and/or conditions are as follows in Table 1.

Table 1: Healthy People 2010 Objectives

Topic	Health People 2010 Objective	
Stroke	12-7	Reduce stroke deaths
Heart Disease	12-1	Reduce coronary heart disease deaths
Diabetes	5-7	Reduce deaths from cardiovascular disease in persons with diabetes
Smoking	27-1	Reduce tobacco use by adults
Blood Pressure	12-9	Reduce the proportion of adults with high blood pressure

Risk Factors

Stroke risk factors include unmodifiable factors such as family history and modifiable risk factors such as smoking. Numerous studies have shown the relationship between increased stroke risk and risk factors such as high blood pressure, high blood cholesterol, smoking, and diabetes.[12,13,14] The following risk factors and conditions in Table 2 increase the risk of having a stroke. More in-depth descriptions of some of these terms can be found in the Glossary.[15] Additional information can also be found at the American Stroke Association or National Stroke Association Web sites.[16,17]

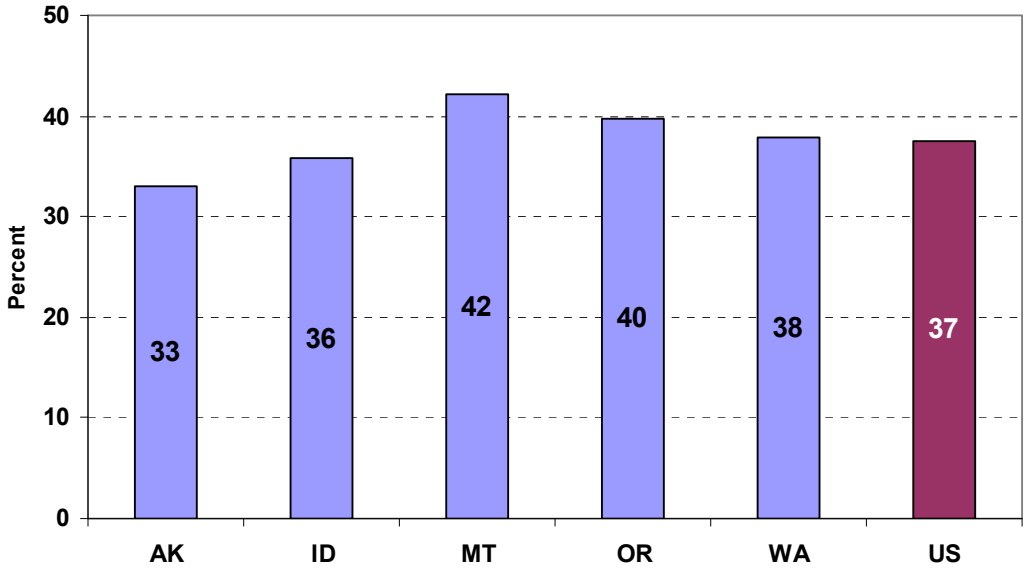
Table 2: Factors Contributing to Stroke Risk

- Smoking
- High blood pressure
- High blood cholesterol
- Cardiovascular disease
- Physical inactivity
- Obesity
- Excessive alcohol intake
- Drug use
- Family history
- Racial background
- Abnormal or insufficient proteins in the blood
- Aging
- Diabetes
- Atrial fibrillation
- Underlying vascular diseases

Health Disparities and Inequities

Reducing health disparities and inequities remains a challenge for those involved in the provision of quality health care. Health disparities exist between different gender, race-ethnicity, age, education, income, poverty status, and rural/urban groups. In the general population, exposure to health risks and access to protective resources are not distributed equally and, as such, the resulting health disparities represent issues of equity. Multiple reasons for these inequities exist and may include the stress and perceived lack of control associated with poverty and the distribution of wealth in the population. An increasing body of literature describes how these inequities are linked to higher rates of disease.[18] A recent article in *Circulation* showed how ischemic stroke was associated with lower educational, poverty, and income status.[19] The following chapters of this report focus on various socio-demographic factors to explore potential inequities in stroke. In order to understand the NW region, we have included a description of each state's population aged 45 years and older in terms of race-ethnicity composition. Gender was not included since each state had a roughly equal proportion of males and females. Income and education were not included because these data were not available in CDC Wonder.

Figure 2: Percent of population aged ≥45 years, US and NW region, 2006 CDC Wonder

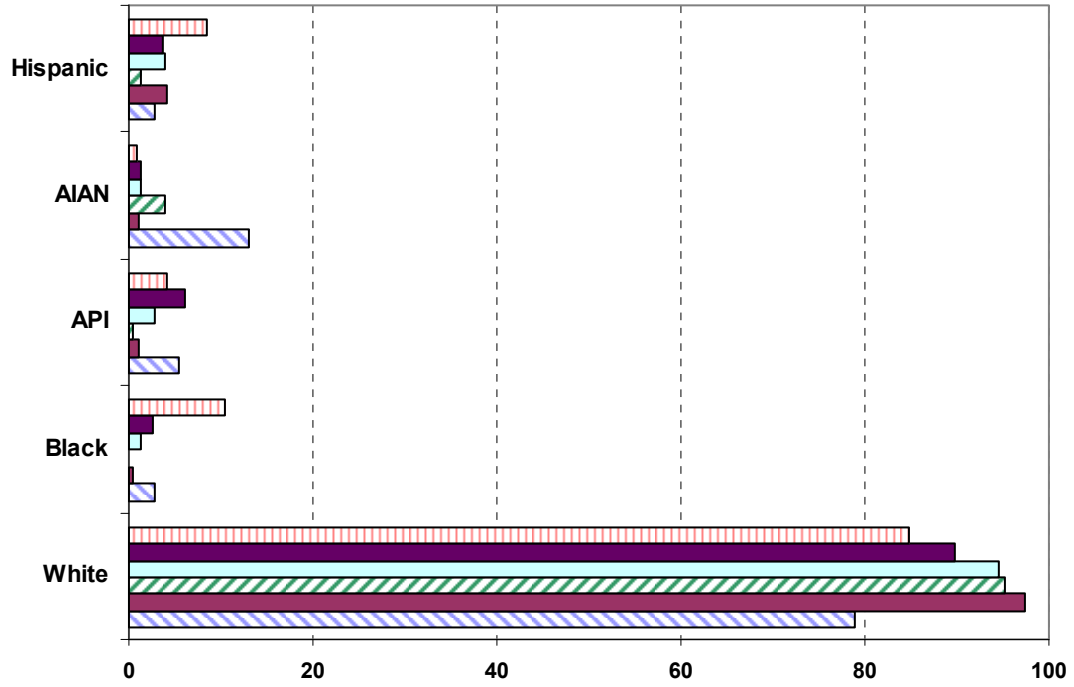


Regional Description: Population Distribution

The percentages of the population aged 45 years and older in 2006 in each state of the NW region and in the United States are shown in Figure 2. The age of 45 years and older was chosen for all analyses. The percentage of the population aged 45 years and older appears to be broadly similar between states. In total, the NW region contained slightly over five million people in 2006 (Alaska: 221,065; Idaho: 524,749; Montana: 398,768; Oregon: 1,471,610; Washington: 2,419,146).

Figure 3 shows the percentage of people in the five states within the NW region and the United States by race and ethnicity. Hispanic ethnicity included all races. The vast majority of residents in the region were white. Of the five states, Alaska appeared to have the lowest percentage of white people and Idaho appeared to have the highest percentage. The state with the highest percentage of American Indian/Alaska Native people appeared to be Alaska, and Washington appeared to have the highest percentage of Asian/Pacific Islander people. The region appeared to have lower percentages of Hispanic and Black people than seen nationally. Statistical testing would be needed to verify these observations.

Figure 3: Percent of Adults ≥45 years by Race-Ethnicity, US & NW Region, 2006 CDC Wonder



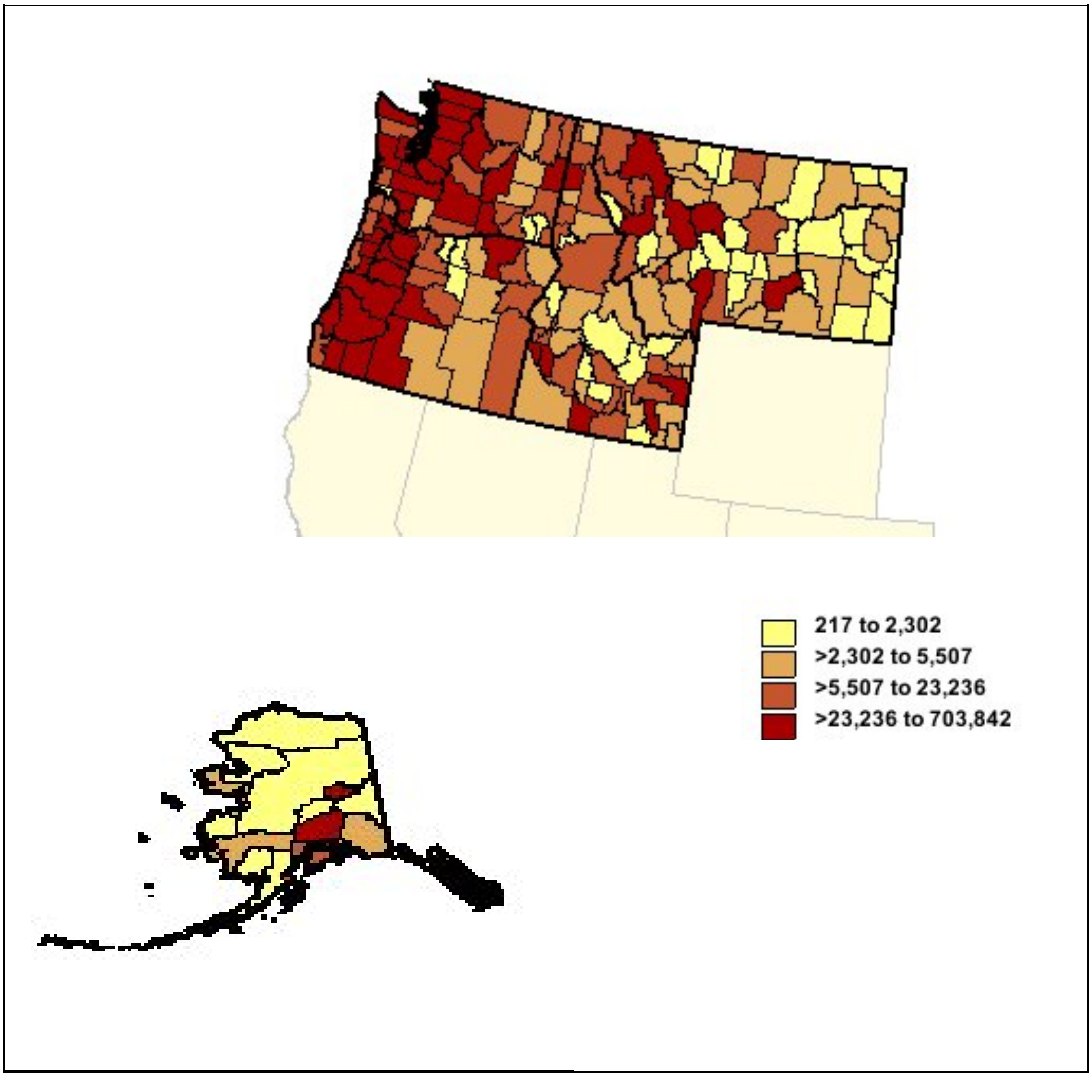
	White	Black	API	AIAN	Hispanic
US	84.8	10.4	4.1	0.8	8.4
WA	89.8	2.7	6.2	1.4	3.8
OR	94.5	1.4	2.9	1.2	3.8
MT	95.3	0.2	0.5	4.0	1.3
ID	97.4	0.4	1.0	1.2	4.2
AK	78.8	2.7	5.4	13.0	2.8

**AIAN: American Indian/Alaska Native; API: Asian/Pacific Islander*

Map 2 shows the number of people aged 45 years and older by county in the states of the NW Region (2006 data from CDC Wonder). As seen in the county map, the majority of people aged 45 years and older live along the coast.

In Alaska, the counties with the highest numbers include Anchorage Borough, Matanuska-Susitna Borough, and Fairbanks North Star Borough. In Idaho, the counties with the highest numbers include Ada, Kootenai, and Canyon County. In Montana, the counties with the highest numbers include Yellowstone, Missoula, Flathead, and Cascade County. In Oregon, the counties with the highest numbers include Multnomah, Washington, Clackamas, and Lane County. In Washington, the counties with the highest number of people aged 45 years or older include King, Pierce, Snohomish, and Spokane County.

Map 2:
Population 45 years of age and older by county, NW Region, 2006 CDC Wonder



Understanding this Report

As previously stated, this report seeks to present a regional perspective on stroke care in the NW region. It is primarily a data report, and is meant to be read in whole to provide insight into what is occurring around stroke in this region. Each chapter contains an overview, background/data sources section, graphs and corresponding descriptions, limitations, and key points to remember.

More in-depth descriptions of the data sources, data analysis methodology, and limitations can be found in Appendix A.

Chapter 2:
People at risk for stroke in the Northwest

Cardiovascular disease, high blood pressure, diabetes, and cigarette smoking are among several important risk factors for stroke.[20] In addition, an estimated one third of people with diabetes and hypertension are undiagnosed in the community and are unaware they have a risk factor for stroke.[21,22]

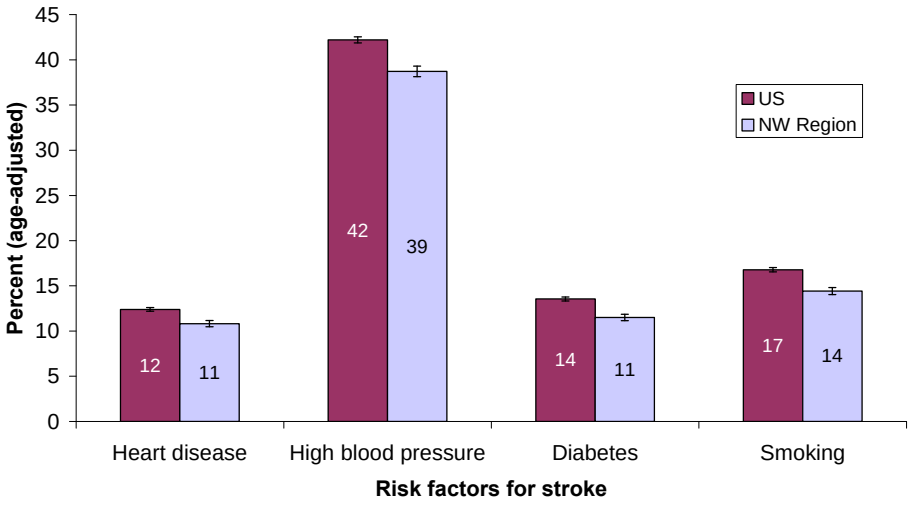
Of those in the NW region aged 45 years and older:

- Thirty-nine percent had diagnosed high blood pressure, making this the most common stroke risk factor examined in this report.
- Eleven percent had diagnosed heart disease.
- Eleven percent had diagnosed diabetes.
- Fourteen percent were current smokers.

This equates to an estimated 0.54 million people with heart disease, 0.58 million people with diabetes, 1.95 million people with high blood pressure, and 0.73 million people who are current smokers in the region, based on CDC Wonder 2006 population estimates. The age-adjusted percentage (prevalence) of stroke risk factors in non-institutionalized adults in the United States and the NW region can be seen in Figure 4.

Heart disease (P<0.001), high blood pressure (P<0.001), diabetes (P<0.001), and smoking (P<0.001) were slightly less common in people aged 45 years and older in the

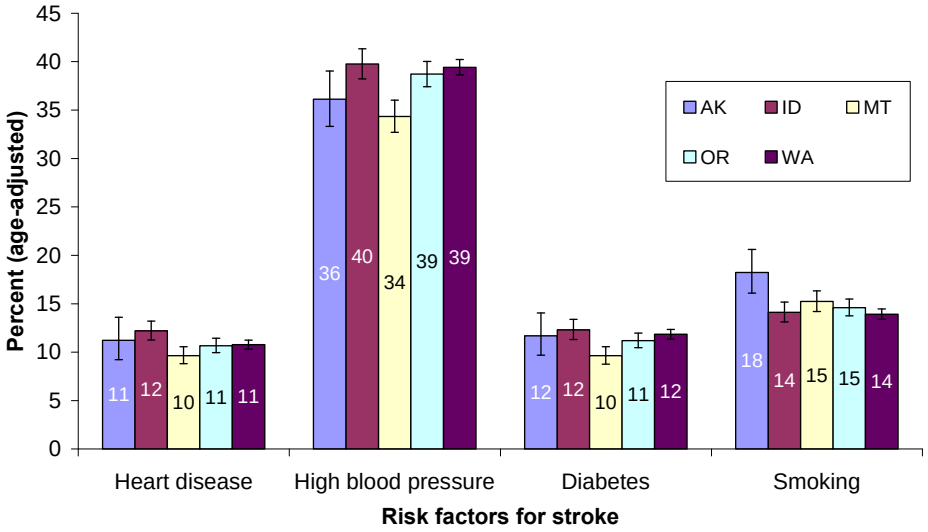
Figure 4: Prevalence of risk factors for stroke in people aged ≥45 years, US and NW region



NW region compared with the rest of the United States (adjusted for age). These differences in prevalence of risk factors between the NW region and the rest of the United States remained after age, sex, race-ethnicity, education, and income differences were taken into account for heart disease (P<0.001), high blood pressure (P<0.001), diabetes (P<0.001), and smoking (P<0.001).

Risk factors in the NW region by state

Figure 5: Prevalence of risk factors for stroke in people aged ≥45 years, NW region by state



Data source: Behavioral Risk Factor Surveillance System data 2005 & 2006 combined (heart disease, diabetes and smoking) and 2003 & 2005 combined (high blood pressure), age-adjusted to US 2000 standard population.

Within the region, the age-adjusted percentage of people with heart disease ranged from ten percent to 12 percent; high blood pressure from 34 percent to 40 percent; diabetes from ten percent to 12 percent; and smoking from 14 percent to 18 percent across states.

Compared with the rest of the region, there were lower age-adjusted percentages of people in Montana with heart disease (P=0.007), high blood pressure (P<0.001) and diabetes (P<0.001), and a higher age-adjusted percentage of smoking in Alaska (P=0.001). These differences remained after age, sex, race-ethnicity, education and income differences between Montana and the rest of the region (heart disease P<0.001; high blood pressure P<0.001; diabetes P<0.001), and Alaska and the rest of the region (smoking P=0.003) were taken into account.

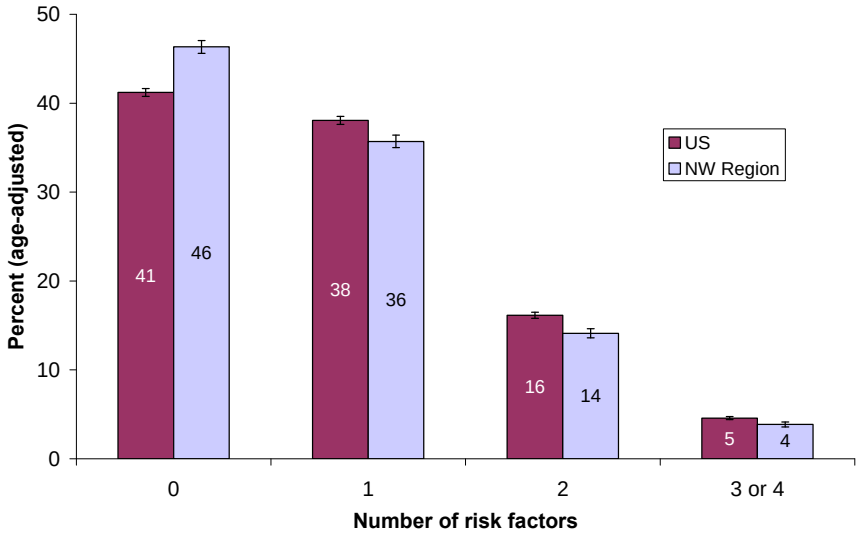
Multiple Risk Factors by NW Region and United States

In the NW region:

- Fifty-four percent of people had one or more risk factors for stroke, including heart disease, high blood pressure, diabetes or smoking (adjusted for age), which equates to an estimated 2.70 million people, based on CDC Wonder 2006 population estimates.
- Eighteen percent of people had two or more risk factors for stroke, including heart disease, high blood pressure, diabetes or smoking (adjusted for age), which equates to an estimated 0.90 million people, based on CDC Wonder 2006 population estimates.
- Four percent of people had three or more risk factors for stroke, including heart disease, high blood pressure, diabetes or smoking (adjusted for age), which equates to an estimated 0.19 million people, based on CDC Wonder 2006 population estimates.

A lower age-adjusted percentage of people in the region had one risk factor (P<0.001), two risk factors (P<0.001), and three or four risk factors (P<0.001) for stroke compared with the rest of the United States, as seen in Figure 6. These differences remained after taking age, sex, race-ethnicity, education and income differences into account between the region and the rest of the United States for percentage of people with one risk factor (P<0.001), two risk factors (P<0.001), and three or four risk factors (P=0.002) for stroke.

Figure 6: Prevalence of risk factors for stroke in people aged ≥45 years, US and NW region, 2005

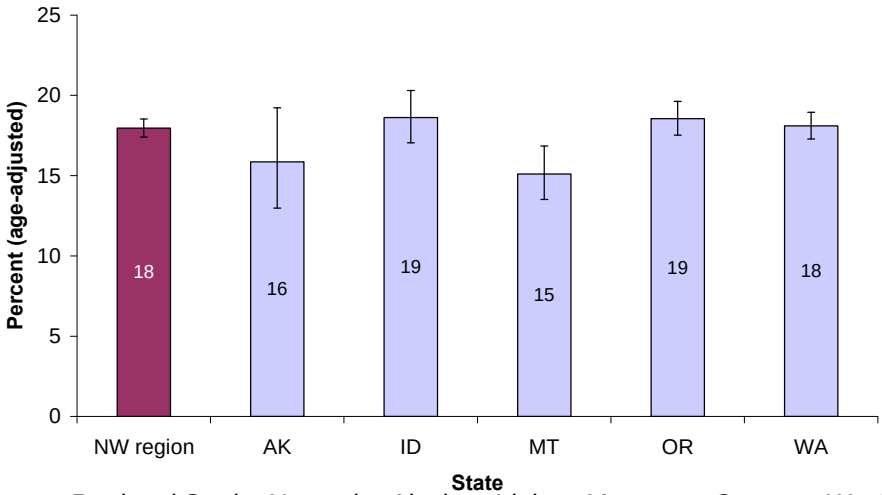


Data source: Behavioral Risk Factor Surveillance System data 2005, age-adjusted to US 2000 standard population.

People with multiple risk factors for stroke are at higher risk for having a stroke than people with one or no risk factor.[23,24] For public health purposes, it is therefore important to identify the population with multiple risk factors for surveillance and potential intervention. We chose to present the percentage of people with two or more risk factors in this report because the percentage of people with three or four risk factors was too low to describe by state or demographic characteristics.

Two or more risk factors in the NW region by state

Figure 7: Prevalence of 2 or more risk factors for stroke in people aged ≥45 years, NW region by state, 2005



Data source: Behavioral Risk Factor Surveillance System data 2005, age-adjusted to U.S. 2000 standard population.

Between 15 percent and 19 percent of people had two or more risk factors for stroke (adjusted for age), including heart disease, high blood pressure, diabetes, or smoking.

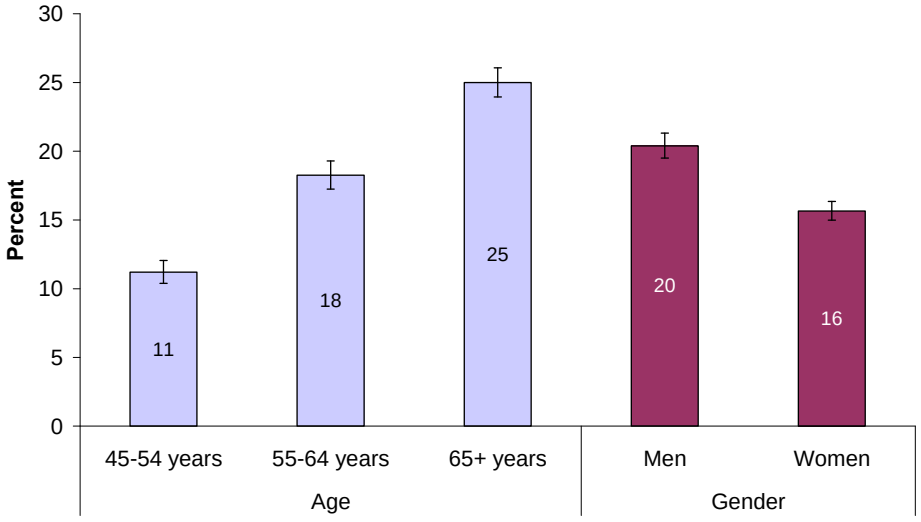
Compared with the rest of the region, Montana had a lower age-adjusted percentage of people with two or more of these risk factors for stroke (P=0.001). This difference remained after taking age, sex, race-ethnicity, education, and income differences into account between Montana and the rest of the NW region (P<0.001).

Two or more risk factors in the NW region by age and gender

The percentage of people with two or more risk factors for stroke increased with age (P for trend <0.001). As seen in Figure 8, 11 percent of people aged 45-54 years had two or more risk factors for stroke compared with 25 percent of people aged 65 years and older. This trend remained after sex, race-ethnicity, education, and income differences between age groups were taken into account (P for trend <0.001).

A higher percentage of men than women (adjusted for age), had two or more risk factors for stroke (P<0.001). This difference was not explained by differences in age, race-ethnicity, education, and income between men and women (P<0.001).

Figure 8: Prevalence of 2 or more risk factors for stroke in people aged ≥45 years, NW region by age and gender, 2005



Data source: Behavioral Risk Factor Surveillance System data 2005, age-adjusted to US 2000 standard population.

**Age-adjusted for gender*

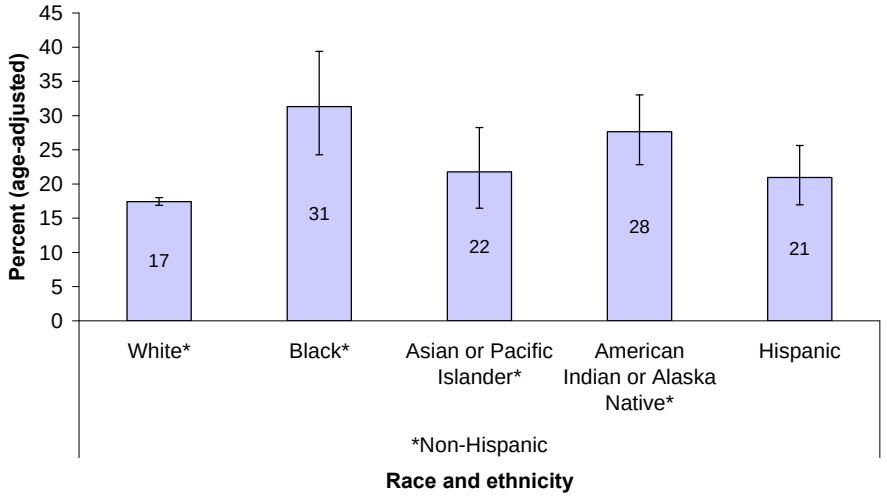
Two or more risk factors in the NW region by race and ethnicity

The age-adjusted percentage of people with two or more risk factors for stroke was almost twice as high in non-Hispanic black people (P<0.001) and 1.6 times higher in non-Hispanic American Indian or Alaska Native people (P<0.001) compared with non-Hispanic white people, as seen in Figure 9.

The higher percentages of people with two or more stroke risk factors in non-Hispanic black (P=0.001) and American Indian/Alaska Native (P=0.001) people compared to non-Hispanic whites remained after age, sex, education and income differences between race-ethnic groups were taken into account.

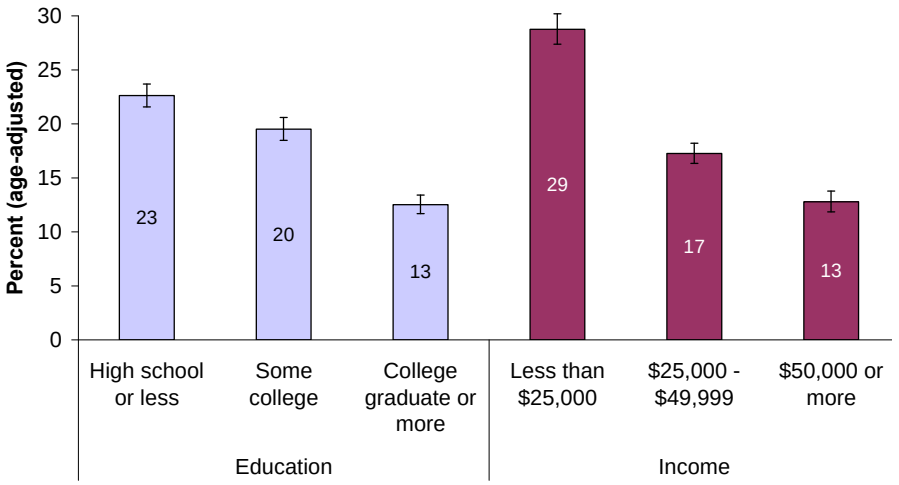
Although, no other differences in age-adjusted percentage of people with two or more stroke risk factors were apparent by race-ethnic group, there was insufficient evidence to exclude the possibility that differences may exist in the population. The small size of non-white and Hispanic populations in the NW region (illustrated by the large confidence intervals in Figure 9) in conjunction with the relatively small magnitude of the absolute differences between groups being tested make comparisons between populations difficult.

Figure 9: Prevalence of 2 or more risk factors for stroke in people aged ≥45 years, NW region by race-ethnicity, 2005



Data source: Behavioral Risk Factor Surveillance System data 2005, age-adjusted to US 2000 standard population.

Figure 10: Prevalence of 2 or more risk factors for stroke in people aged ≥45 years, NW region by education and income status, 2005



Data source: Behavioral Risk Factor Surveillance System data 2005, age-adjusted to US 2000 standard population.

The age-adjusted percentage of people with two or more risk factors for stroke decreased with increasing education (P for trend <0.001) and household income (P for trend <0.001).

Twenty-three percent of people with a high school education or less had two or more risk factors for stroke compared with 13 percent of people with a college degree or more (adjusted for age). Twenty-nine percent of people with a household income of less than $25,000 had two or more risk factors for stroke compared with 13 percent of people with a household income of $50,000 or more (adjusted for age).

These trends remained after age, sex, and race-ethnicity differences between education (P for trend <0.001) and income groups (P for trend <0.001) were taken into account.

Key Points

- In the NW region, more than one in every three adults aged 45 years and older had high blood pressure, one in every nine had heart disease, one in every nine had diabetes, and one in every seven was a current smoker, making high blood pressure the most common of these risk factors in this age group.
- These values are likely to be greatly underestimated due to the high percentage of people with undiagnosed stroke risk factors in the community, making the true burden of stroke risk factors much greater than suggested in this report.
- The percentage of adults with stroke risk factors was lower in the NW region compared with the rest of the United States.
- Montana had a lower percentage of adults with high blood pressure, diabetes, and heart disease compared with the rest of the NW region.

- Alaska had a higher percentage of current smokers compared with the rest of the NW region.
- Half of the adults in the NW region had one or more stroke risk factors, one in every six adults had two or more stroke risk factors and one in every 26 adults had three or more stroke risk factors in this age group.
- Populations in the NW region with the highest percentage of two or more stroke risk factors included men, older adults aged 65 years and over, non-Hispanic blacks, non-Hispanic American Indians/Alaska Natives, and those with lowest household income, and least educational attainment.

Background and Data Sources

Available data on the number of people with risk factors for stroke in the NW region and United States came from the Behavioral Risk Factor Surveillance System (BRFSS) dataset maintained by the CDC (see Appendix A). The BRFSS survey captures data on self-reported medically diagnosed heart disease (defined as myocardial infarction, angina or coronary heart disease), medically diagnosed high blood pressure, medically diagnosed diabetes, and smoking from adults living in the community who were not currently in an institution or hospital. Adults with stroke risk factors not captured in BRFSS include those with undiagnosed risk factors in the community, people with risk factors currently in hospital, people with risk factors whose disabilities that prevent them from participating in a telephone survey, and people with risk factors who have died, and as such the percentage of adults with risk factors will be an underestimate. Population estimates were obtained from CDC Wonder.

Limitations:

The following limitations of the data and analyses must be taken into account when reviewing these findings:

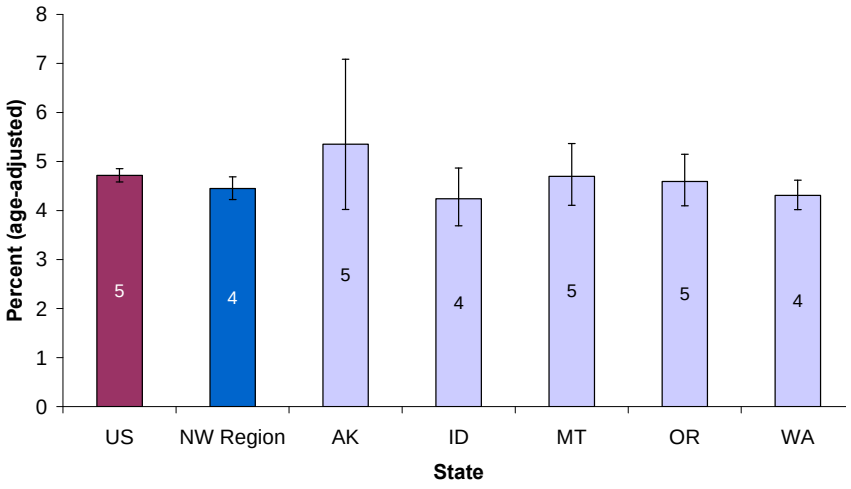
- Potential selection, survivor and recall biases in the BRFSS survey (see Appendix A for details).
- People less likely to have home telephones such as poor, mobile and ethnically diverse people may be under-represented in the BRFSS survey
- People with stroke risk factors who are currently in-hospital, whose disabilities prevent them from participating in a telephone survey, or who have died are not captured in the BRFSS survey. As stroke and stroke risk factors, especially heart disease, commonly lead to disability and death this could potentially impact findings by underestimating people with stroke risk factors.
- The number of survey respondents in this analysis corresponds to 0.51 percent of the population aged 45 years and older in the NW region in 2006 (based on population estimates from CDC Wonder).
- Data should be interpreted with caution due to concerns about lack of precision and the ability to generalize to the whole population.

Chapter 3:
People with stroke in the Northwest

An estimated five million U.S. adults have been diagnosed with stroke, equal to about two percent of the population.[6,7] The age-adjusted percentage of adults aged 45 years and older living in the community with stroke was similar in the NW region and the rest of the United States (P=0.03).

Specifically, in the NW region, four percent of adults aged 45 years and older have survived a stroke (adjusted for age), corresponding to 0.22 million people based on CDC Wonder 2006 population estimates. The age-adjusted percentage of adults with stroke was similar in each state with that of the rest of the region: Alaska P=0.27, Idaho P=0.45, Montana P=0.44, Oregon P=0.40 and Washington P=0.18.

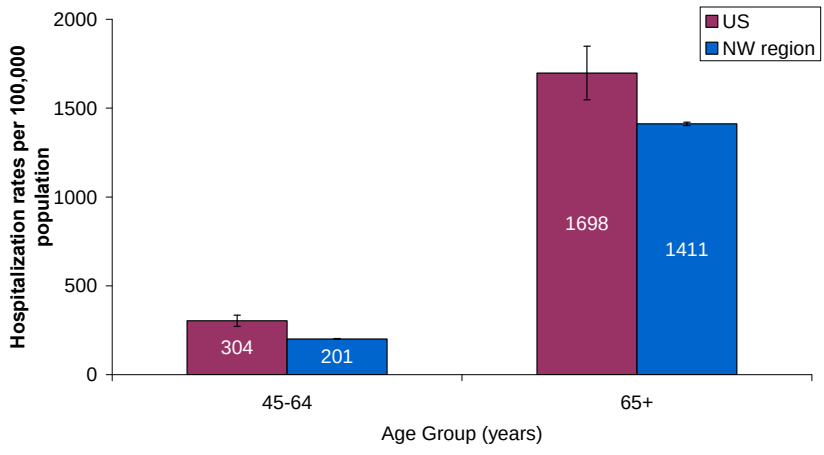
Figure 11: Prevalence of stroke in people aged ≥45 years, US and NW region, 2005-2006



Data source: Behavioral Risk Factor Surveillance System data 2005 & 2006 combined, age-adjusted to US 2000 standard population.

Stroke hospitalization rates in the United States and NW region

Figure 12: Stroke hospitalization rates per 100,000 population in people aged ≥45 years, US (2005) and NW region (2001-2005), by age



Data source: Hospitalization and population data Alaska, Montana, Oregon and Washington, 2001 to 2005 combined. National Hospital Discharge Survey 2005. Crude age-specific hospitalization rate presented.

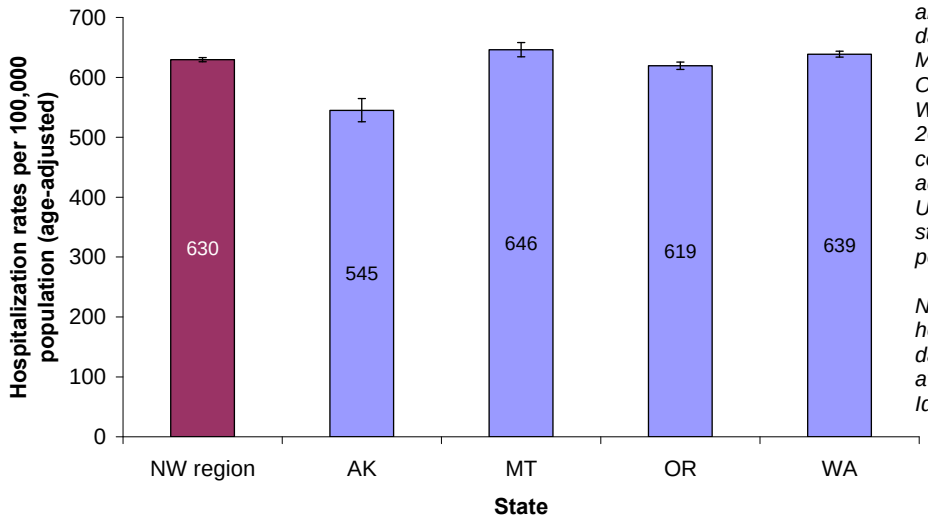
NOTE: No hospitalization data were available from Idaho.

In the NW region (excluding Idaho where no hospitalization data were available), stroke hospitalization rates were 201 hospitalizations per 100,000 in adults aged 45-64 years and 1,411 hospitalizations per 100,000 population in adults aged 65 years and older between 2001 and 2005.

Age-specific rates may be higher in the United States as a whole in 2005. However, differences in time periods, study design and the inability to adjust rates for age within broad age groups and other factors made comparisons between the United States and the NW region difficult. See Appendix A for details.

Stroke hospitalization rates include hospitalizations that occur within a specific time period, such as between 2001 and 2005. Meanwhile, the percentage of people who reported having had a stroke includes all stroke events regardless of when they occurred. Therefore, stroke hospitalization rates and the percentage of people with stroke cannot be compared directly.

Figure 13: Stroke hospitalization rates per 100,000 population aged ≥45 years, NW region, 2001-2005



Data source: Hospitalization and population data: Alaska, Montana, Oregon and Washington, 2001 to 2005 combined. Age adjusted to the US 2000 standard population.

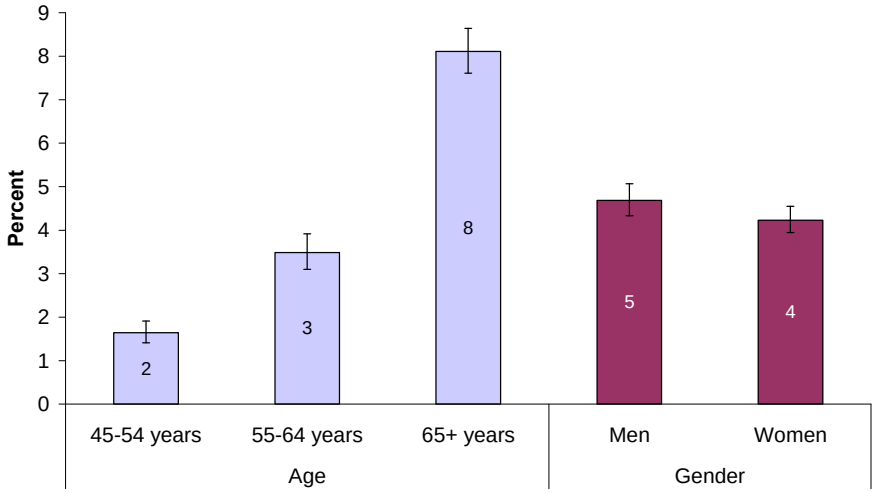
NOTE: No hospitalization data were available from Idaho.

In the region (including Alaska, Montana, Oregon and Washington), between 2001 and 2005, there were 120,550 hospitalizations for stroke in adults aged 45 years and older. This equates to an annual average of 24,110 hospitalizations in these four states combined and an age-adjusted hospitalization rate of 630 hospitalizations per 100,000 population. Stroke hospitalization age-adjusted rates were lower in Alaska ($P<0.001$) and Oregon ($P<0.001$), and higher in Montana ($P=0.004$) and Washington ($P<0.001$), compared with the rest of the region for which hospitalization data were available.

Data were unavailable to assess if these differences could be explained by differing population demographic characteristics between states.

People living with stroke in the NW region by age and gender

Figure 14: Prevalence of stroke in people aged ≥45 years, NW region by age and gender, 2005-2006



Data source: Behavioral Risk Factor Surveillance System data 2005 & 2006 combined. Data presented by gender, age-adjusted to U.S. 2000 standard population.

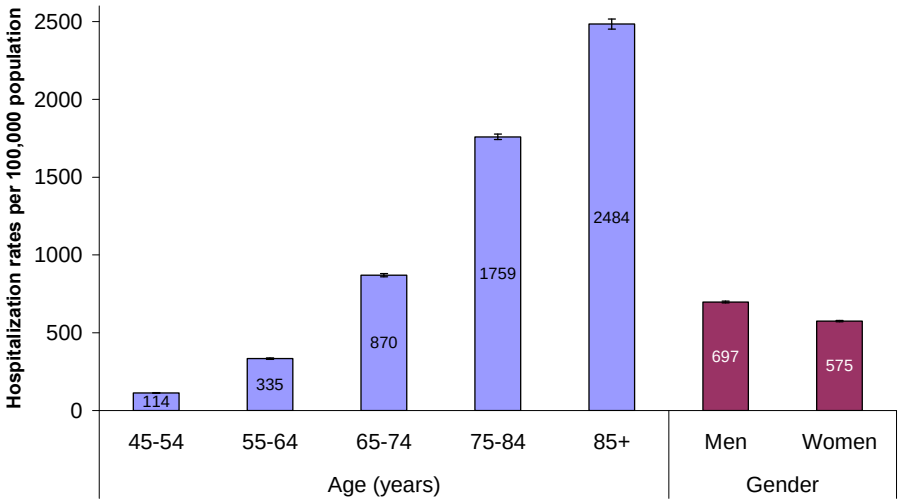
**Age-adjusted for gender*

In the NW region, the percentage of adults aged 45 years and older with stroke increased with age (P for trend <0.001). Two percent of people aged 45-54 years living in the community have had a stroke compared with eight percent of people aged 65 years and older. This trend remained after sex, race-ethnicity, education, and income differences were taken into account (P for trend <0.001).

As seen in Figure 14, a similar percentage of both men and women adjusted for age have had a stroke (P=0.05). However, after taking into account differences in age and income (P<0.001), and then separately, age and education (P=0.003) between the gender groups, a slightly higher percentage of men than women reported having had a stroke.

Stroke hospitalization rates in the NW region by age and gender

Figure 15: Stroke hospitalization rates per 100,000 population aged ≥45 years, NW region by age and gender, 2001-2005



Data source: Hospitalization and population data, Alaska, Montana, Oregon and Washington, 2001 to 2005 combined. Data presented by gender are age-adjusted to U.S. 2000 standard population.

NOTE: No hospitalization data were available from Idaho.

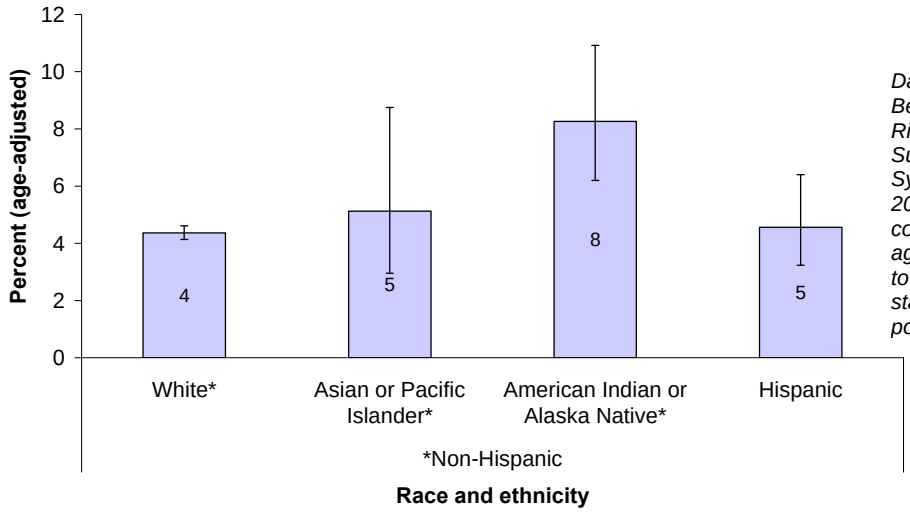
**Age-adjusted for gender*

Stroke hospitalization rates increased with age (P for trend=0.004). The rate of hospitalizations for stroke in adults aged 45-54 years was 114 per 100,000 population compared with 2,484 per 100,000 for adults aged 85 years and older.

Age-adjusted stroke hospitalization rates per 100,000 population were higher in men than in women (P<0.001). Data were unavailable to assess whether differences could be explained by differing population socio-demographic characteristics between age and gender groups.

Stroke prevalence in the NW region by race and ethnicity

Figure 16: Prevalence of stroke in people aged ≥45 years, NW region by race and ethnicity, 2005-2006



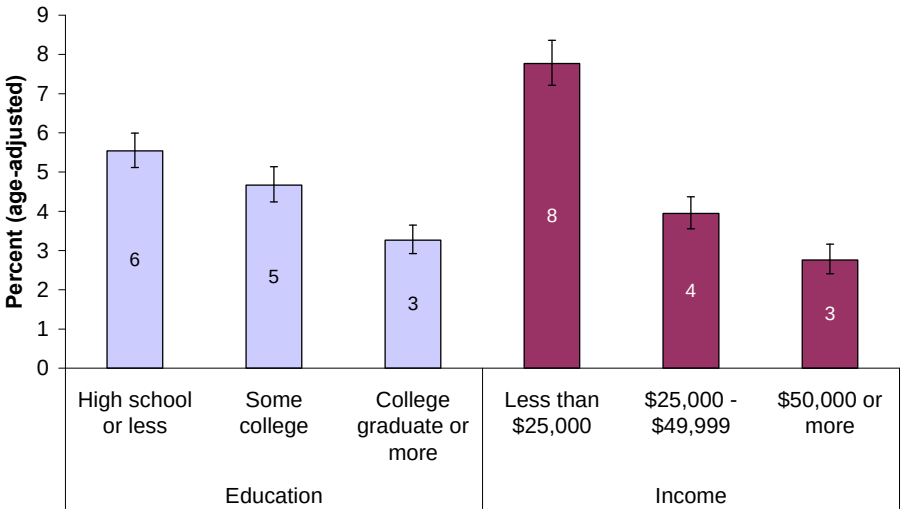
Data source: Behavioral Risk Factor Surveillance System data 2005 & 2006 combined, age-adjusted to U.S. 2000 standard population.

The age-adjusted percentage of adults with stroke was almost twice as high in non-Hispanic American Indian or Alaska Native people compared with non-Hispanic white people (P<0.001). This remained after age, sex, education and income differences between these racial and ethnic groups were taken into account (P=0.002).

- No other differences in age-adjusted percentage of people with stroke were apparent by race-ethnic group, although there was insufficient evidence to exclude the possibility that differences exist in the population. The small size of non-white and Hispanic populations in the NW region (illustrated by the large confidence intervals in Figure 16) in conjunction with the relatively small magnitude of the absolute differences between groups being tested, make comparisons between populations difficult.
- Data for the age-adjusted percentage of non-Hispanic black people with stroke was suppressed as the small sample size was associated with too large an error to present. In addition, caution should be taken when interpreting the age-adjusted percentage for non-Hispanic Asian or Pacific Islander due to small sample size (see Appendix A for details).
- Data on age-adjusted stroke hospitalization rate by race-ethnicity were unavailable.

Stroke prevalence in the NW region by education and income

Figure 17: Prevalence of stroke in people aged ≥45 years, NW region by education and household income, 2005-2006



Data source: Behavioral Risk Factor Surveillance System data 2005 & 2006 combined, age-adjusted to U.S. 2000 standard population.

The age-adjusted percentage of adults with stroke decreased with increasing education (P for trend <0.001) and household income (P for trend <0.001), as can be seen in Figure 17.

Six percent of people with a high school education or less have had a stroke compared with three percent of people with a college degree or more (adjusted for age).

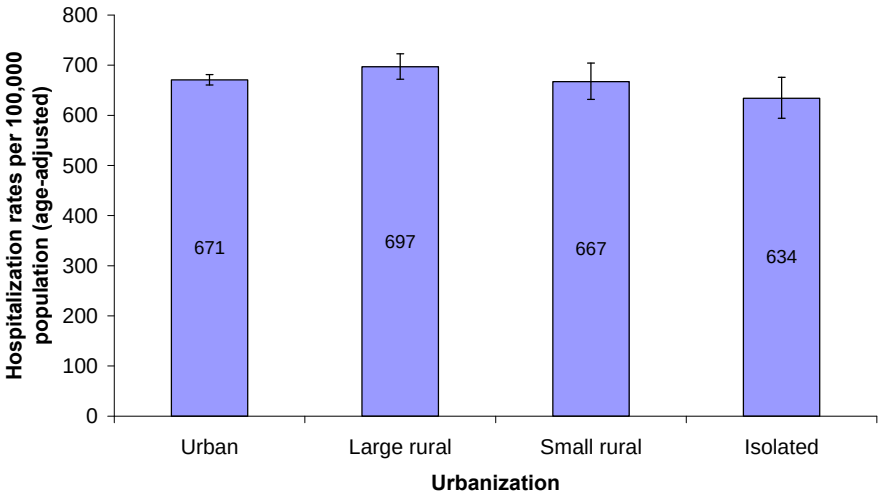
Similarly, eight percent of people with a household income of <$25,000 have had a stroke compared with three percent of people with a household income of ≥$50,000 (adjusted for age). These trends remained after age, sex, and race-ethnicity differences between education (P for trend <0.001) and income groups (P for trend <0.001) were taken into account.

Data on age-adjusted stroke hospitalization rate by education and income were unavailable.

Stroke hospitalizations in the NW region by urbanization

In the NW region (including Alaska, Oregon and Washington), age-adjusted stroke hospitalization rates were similar in urban and rural areas (P for trend=0.74). As illustrated in Figure 18, the confidence interval of the hospitalization rate in isolated areas included the hospitalization rate in urban areas.

Figure 18: Stroke hospitalization rates in people aged ≥45 years, NW region by urbanization, 2001-2005



Data source: Hospitalization data, Alaska, Oregon and Washington, 2001 to 2005 combined. U.S. 2000 Census (population) data Alaska, Oregon and Washington. Age-adjusted to U.S. 2000 standard population.

NOTE: No hospitalization data were available from Idaho, and urbanization data were unavailable from Montana.

Data were unavailable to assess whether differences in population demographic characteristics such as race-ethnicity, education, and income between urban and rural areas were masking a potential relationship between urbanization and hospitalization rates.

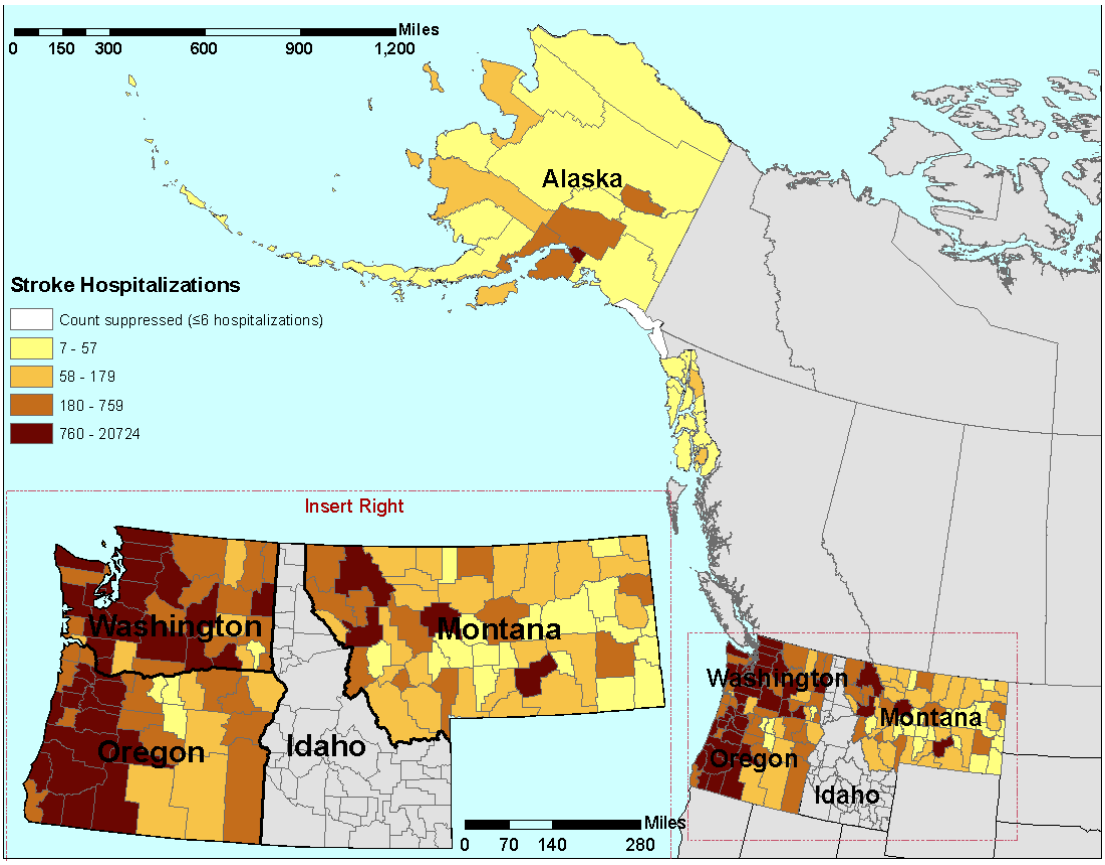
Data on age-adjusted percentage of people in the community with stroke by urbanization were unavailable at the time of analysis.

Stroke hospitalization counts by county

In the NW region (excluding Idaho where no data were available), the number of stroke hospitalizations by county of residence from 2001 through 2006 combined ranged from seven to 20,724 in adults aged 45 years and older. The stroke hospitalization count of one county was suppressed as it contained less than seven hospitalizations during the six-year period.

The counties with the highest number of stroke hospitalizations matched closely with areas of high population, and tended to be along the Pacific coast of Washington and Oregon.

Map 3: Regional map of stroke hospitalization counts by county, 2001-2006



Data source: Hospitalization and population data Alaska, Montana, Oregon and Washington, 2001 to 2006 combined. No hospitalization data were available from Idaho.

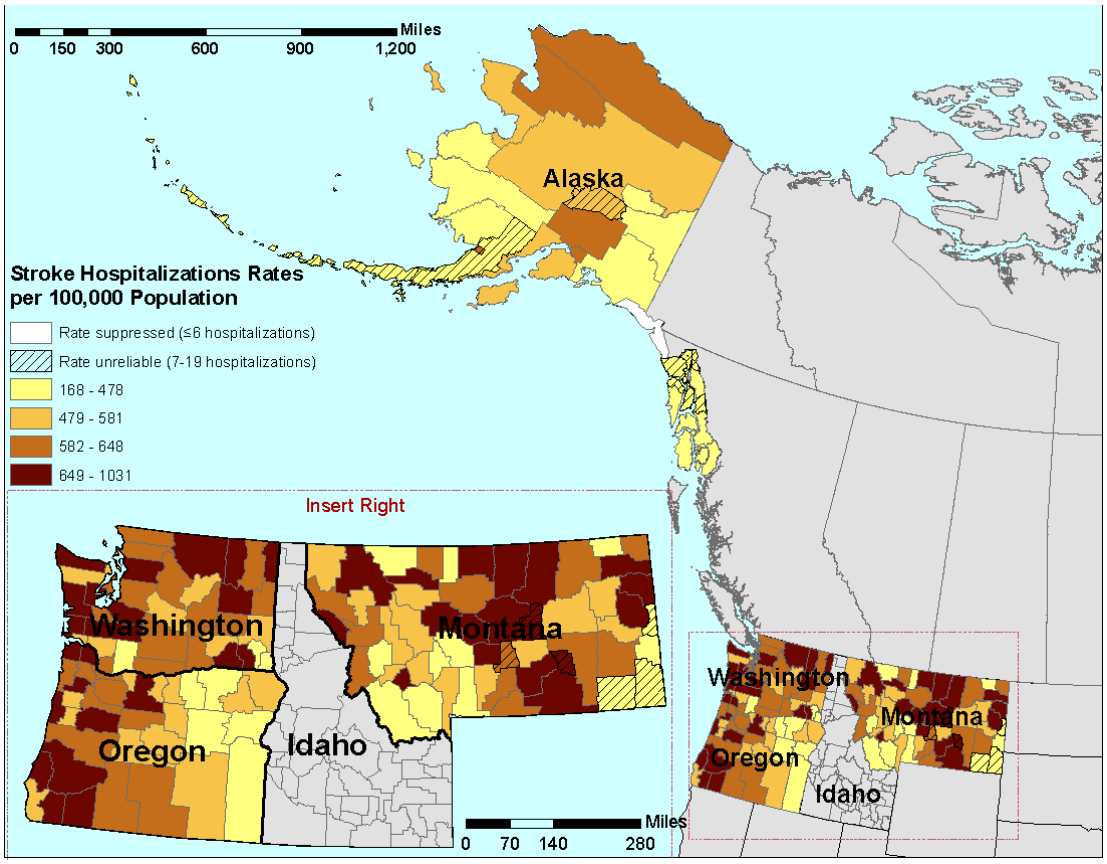
Stroke hospitalization rates by county

In the NW region, age-adjusted stroke hospitalization rates in adults aged 45 years and older by county ranged from 168 to 1,031 per 100,000 population. Age-adjusted stroke hospitalization rates from 14 counties were suppressed or considered unreliable as they were based on fewer than 20 hospitalizations during the six-year period.

The counties with the highest age-adjusted stroke hospitalization *rates* included both densely populated and sparsely populated areas. This was in contrast to the map of stroke hospitalization *counts* (above section), where stroke hospitalization counts tended to align with population size. Between the contiguous states in the region, although there appeared to be differences in age-adjusted stroke hospitalization rates between bordering counties that were along state lines, statistical tests were not performed due to time constraints. It was unknown, therefore, if these hospitalization rates were truly different from each other or from the hospitalization rate in the rest of the region.

Age-adjusted stroke prevalence was not assessed by county due to small sample size. Therefore, the relationship between hospitalization rates and stroke prevalence at the county level is unknown.

Map 4: Regional map of stroke hospitalization rates by county, 2001-2006

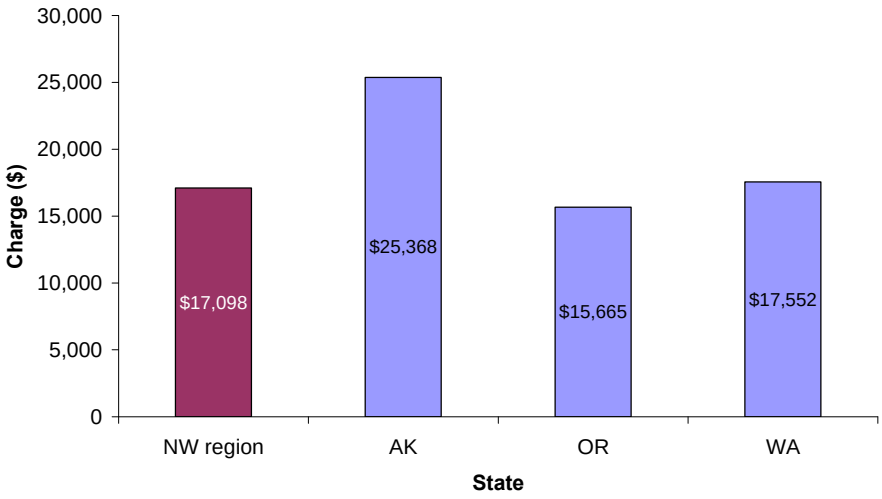


Data source: Hospitalization and population data, Alaska, Montana, Oregon and Washington, 2001 to 2006 combined. Age-adjusted to U.S. 2000 standard population. No hospitalization data were available from Idaho.

Stroke hospitalization charges and length of hospital stay in the NW region

In the states of Alaska, Oregon, and Washington (charge data were unavailable from Montana and Idaho) the average hospital charge per stroke hospitalization was $17,098 for adults aged 45 years and older. The average length of hospital stay due to stroke was four days (using data from Alaska, Montana, Oregon, and Washington).

Figure 19: Average charge per stroke hospitalization in people aged ≥45 years, NW region, 2001-2005



Data source: Hospitalization data Alaska, Montana, Oregon and Washington, 2001 to 2005 combined.

NOTE: No hospitalization data were available from Idaho, and no hospitalization charge data were available from Montana.

Applying this average charge to the number of stroke hospitalizations in Alaska, Montana, Oregon and Washington, we estimate hospital charges due to stroke in the NW region to be over $412 million per year. However, this is an underestimate since it does not take into account stroke hospitalizations in Idaho for which data were unavailable. Although, data were unavailable at the time of analysis to assess differences in average charge per stroke hospitalization between the NW region and the states, it appeared that the average charge per stroke hospitalization was higher in Alaska than in the rest of the region.

Key Points

- In adults aged 45 years and older in the NW region, one in every 25 people living in the community has had a stroke; there were on average 24,110 stroke hospitalizations per year; and the stroke hospitalization rate was 630 hospitalizations per 100,000 population.
- These values are likely to be an underestimate of the true burden of stroke due to the omission of undiagnosed stroke in the community, people with stroke unable to participate in the community survey due to disability, people who died from stroke before admission to a hospital, and the lack of hospital data from Idaho.
- Percentage of people aged 45 years and older with stroke was similar in the United States, the NW region, and each state within the region.

- Stroke hospitalization rates were lower in Alaska and Oregon and higher in Montana and Washington than in the rest of the region.
- Populations with the highest percentages of people with stroke included men, older adults aged 65 years and over, non-Hispanic American Indian or Alaska Native people, and those with lowest household income and least educational attainment. Stroke hospitalizations per 100,000 population similarly increased with age and were higher in men than in women.
- Stroke hospitalization rates in adults aged 45 years and older in the NW region were similar across urban and rural areas.
- High stroke hospitalization rates in adults aged 45 years and older were observed in both urban and rural counties in the NW region and may have differed between counties that border each other along state lines.
- Four days was the average length of hospital stay for stroke in adults aged 45 years and older in the NW region.
- The average charge per stroke hospitalization in adults aged 45 years and older was $17,098, in the NW region, amounting to over $412 million every year.

Background and Data Sources

Available data on the number of strokes in the NW region and United States came from the Behavioral Risk Factor Surveillance System (BRFSS) and the National Hospitalization Discharge Survey (NHDS) maintained by the CDC, and state level hospitalization data maintained by hospital associations (see Appendix A). The BRFSS survey captures data on self-reported medically diagnosed stroke from adults living in the community, and as such stroke survivors, who were not in an institution or hospital at time of survey. People with stroke not captured in BRFSS included those with undiagnosed stroke in the community and those disabled from stroke such that they were unable to participate in a telephone survey. The percentage of adults with stroke, therefore, will be an underestimate. For hospitalizations, the unit of measurement is a hospitalization and not an individual, and as such if one person was hospitalized three times in one year for stroke they were counted three times. For the purposes of this report, first listed diagnosis was used to identify hospitalizations due to stroke. No hospitalization data were available for Idaho. Population estimates were obtained from CDC Wonder.

Limitations:

The following limitations of the data and analyses must be taken into account when reviewing these findings:

- Potential selection, survivor and recall biases in the BRFSS survey (see Appendix A for details).
- People less likely to have home telephones such as poor, mobile and ethnically diverse people may be under-represented in the BRFSS survey.
- People with stroke who are in a hospital, whose disabilities from stroke prevent them from participating in a telephone survey, or who have died after a stroke are not captured in the BRFSS survey. As stroke commonly leads to disability and death, this could potentially impact findings by underestimating people who have had a stroke.
- The number of BRFSS survey respondents in this analysis corresponded to 0.51 percent of the population aged 45 years and older in the NW region in 2006 (based on population estimates from CDC Wonder).
- Potential selection biases in the hospitalization dataset included the missing hospitalization data from Idaho, the difference in co-morbidities and post-stroke survival between people with a first listed diagnosis of stroke versus any listed diagnosis of stroke, the predominance of men and lower socioeconomic groups in the Veterans

Administration hospital population of which only Washington included data in this report, and the systematic omission of data from particular types of hospitals across the NW region (see Appendix A for details).

- The potential impact on findings of repeated stroke hospitalizations by the same individual, misclassification of county of residence of hospitalization due to the reliance on zip codes that can cross county-boundaries, use of 2000 population data as a denominator for one-year average stroke hospitalizations from 2001-2005 to calculate stroke hospitalization rate by category of urbanization, and the potential disease misclassification of stroke are unknown.
- The extent to which systematic differences in hospitalization data collection or data abstraction practices between states could explain findings is unknown.
- Data should be interpreted with caution due to concerns about lack of precision and the ability to generalize to the whole population.

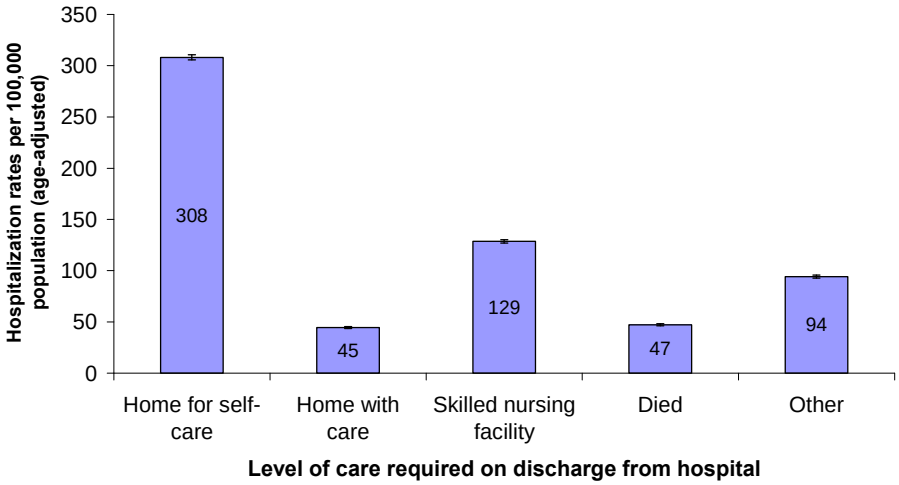
Chapter 4:
People disabled from stroke in the Northwest

Stroke is one of the leading causes of disability in the United States. In 1999, an estimated 1.1 million Americans experienced functional limitations, difficulty with activities of daily living, or other disabilities due to stroke.[25] Of adults aged 65 years and older, 26 percent needed assistance with activities of daily living, 31 percent were unable to walk without help, and 26 percent were institutionalized in a nursing home six months after having had a stroke.[26] After a hospitalization for stroke, patients can be discharged to a variety of places depending on the level of required follow-up care.

Level of care required after hospital discharge in the NW region

In the NW region (including Alaska, Montana, Oregon and Washington), the age-adjusted stroke hospitalization rate for people able to care for themselves at home after leaving the hospital was 308 hospitalizations per 100,000 population. This constituted half of the age-adjusted stroke hospitalization rates in the region where data were available, at 630 hospitalizations per 100,000 population. However, the age-adjusted stroke hospitalization rate for people who required skilled nursing care on discharge from the hospital was 129 stroke hospitalizations per 100,000 population, and for people who required home care on hospital discharge the rate was 45 hospitalizations per 100,000 population. Forty-seven stroke hospitalizations per 100,000 population, adjusted for age, resulted in death, as can be seen in Figure 20.

Figure 20: Stroke hospitalization rates per 100,000 population in people aged ≥45 years by level of care required on hospital discharge, NW region, 2001-2005

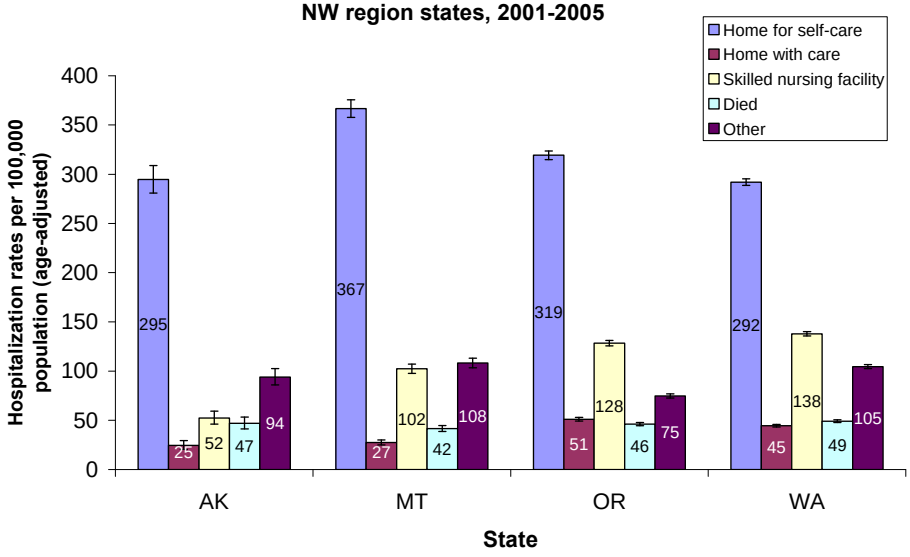


Data source: Hospitalization and population data, Alaska, Montana, Oregon, and Washington, 2001-2005 combined. Age-adjusted to the U.S. 2000 standard population.

NOTE: No hospitalization data were available for Idaho.

Level of care required after hospital discharge in the NW region by state

Figure 21: Stroke hospitalization rates per 100,000 population in people aged ≥45 years by level of care required on hospital discharge, NW region states, 2001-2005



Data source: Hospitalization and population data, Alaska, Montana, Oregon, and Washington, 2001 to 2005 combined. Age-adjusted to the U.S. 2000 standard population.

NOTE: No hospitalization data were available for Idaho

Compared with the rest of the NW region (excluding Idaho where no data were available), the age-adjusted stroke hospitalization rates for people discharged to skilled nursing facilities were lower in Alaska (P<0.001) and Montana (P<0.001), and higher in Washington (P<0.001). The age-adjusted rate of discharge to a skilled nursing facility was similar in Oregon with the rest of the NW region (P=0.66).

Age-adjusted stroke hospitalization rates for people discharged to their own home with care were lower in Alaska (P<0.001) and Montana (P<0.001), higher in Oregon (P<0.001), and similar in Washington (P=0.98) compared with the rest of the NW region with available data.

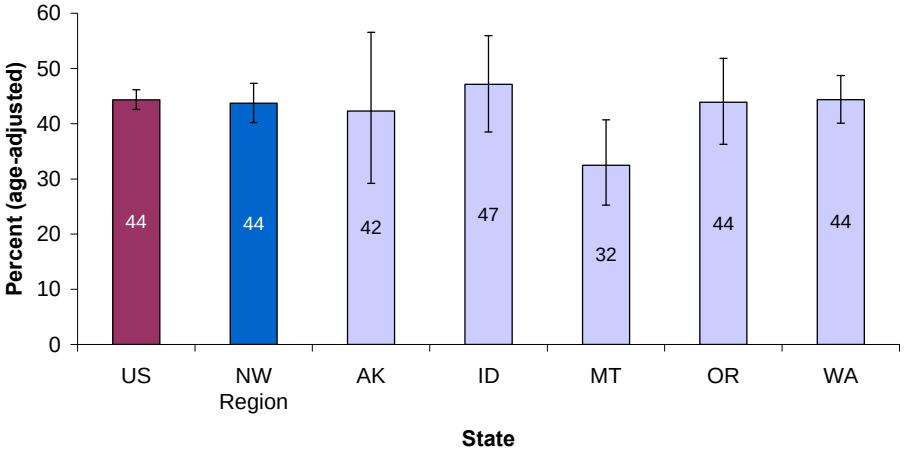
Age-adjusted stroke hospitalization rates for people who died in a hospital were lower in Montana (P=0.0003) and higher in Washington (P=0.0001) than in the rest of the NW region with available data.

A description of the discharge status categories included within the 'other' group can be found in Appendix A.

Limitations in usual activities in the United States and NW region

In both the United States and NW region, 44 percent of people with stroke, adjusted for age, reported one or more days in the past month where poor mental or physical health limited their usual activities such as work or self-care.

Figure 22: Prevalence of 1+ days of poor mental or physical health in the past month limiting usual activities such as work or self-care in people with stroke aged ≥45 years, US and NW region, 2005-2006

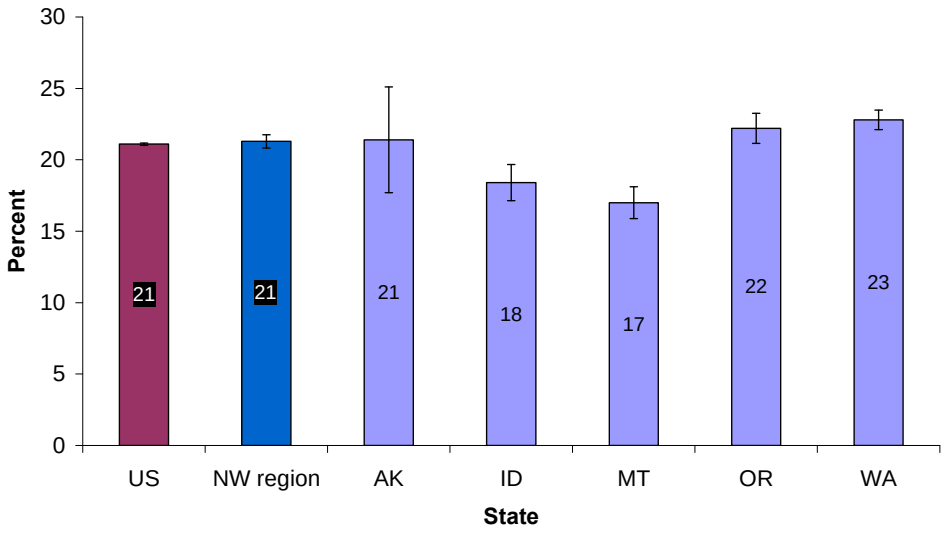


Data source: Behavioral Risk Factor Surveillance System data 2005 & 2006 combined, age-adjusted to US 2000 standard population.

The age-adjusted percentage of people with stroke reporting one or more days in the past month of limited usual activities due to poor health was similar in each state compared with the rest of the NW region (Alaska P=0.46, Idaho P=0.39, Montana P=0.10, Oregon P=0.68 and Washington P=0.57).

Nursing home residents with stroke in the United States and NW region

Figure 23: Prevalence of stroke among nursing home residents, US and NW region, 2007



Data source: Centers for Medicare and Medicaid Services Minimum Data Set Active Resident Information Report, First Quarter 2007

NOTE: Percentages are not adjusted for age

Twenty-one percent of nursing home residents had a diagnosis of stroke that currently impacts their function or care plan, amounting to 7,848 out of 36,854 people.

The percentage of nursing home residents with a diagnosis of stroke appeared to be similar in the NW region to that of the rest of the United States (P=0.41); and within the NW region, appeared to be lower in Idaho (P<0.001) and Montana (P<0.001) and higher in Washington (P<0.001) compared with the rest of the region.

Data were unavailable to adjust percentages for age.

Nursing home costs for residents with stroke in the NW region

The average cost of a private room in a nursing home ranged from $164 to $578 per day, and that of a semi-private room ranged from $132 to $570. Based on the U.S. daily average cost of a private room in a nursing home of $206 and the number of nursing home residents with a diagnosis of stroke in the region of 7,848 (see above), the estimated cost of nursing home care for stroke in the NW region was over $1.6 million per day and $590 million per year.

Table 3:
Average daily cost of a semi-private and private room in a nursing home in the United States and NW region[27]

State	Area	Average daily cost of semi-private room	Average daily cost of private room
Alaska	Statewide	$570	$578
Idaho	Boise	$165	$179
Montana	Billings	$132	$164
Oregon	Portland	$179	$199
	Eugene	$170	$173
Washington	Seattle	$218	$239
	Spokane	$203	$219
United States		$183	$206

The estimated cost of nursing home care in the NW region using the semi-private room rate was not presented due to the similarity to that of the estimated annual cost of nursing care using the private room rate.

Key Points

- People able to care for themselves at home after leaving the hospital constituted almost half of the stroke hospitalization rate in those aged 45 years and older in the NW region. However, people who required skilled nursing facility care after hospital discharge constituted a fifth of the stroke hospitalization rate.
- Rates of hospital discharge to a skilled nursing facility were lower in Alaska and Montana and higher in Washington compared with the rest of the NW region.
- Rates of hospital discharge to the patients' own home with care were lower in Alaska and Montana and higher in Oregon compared with the rest of the NW region.
- Slightly under half of adults with stroke reported one or more days in the past month when poor mental or physical health limited usual activities such as work or self-care in the NW region.

- One in five nursing home residents in the NW region had a diagnosis of stroke that impacts their function or care plan.
- The average daily cost of private nursing home care for stroke in the NW region ranged from $164 - $578 per day. The highest daily costs were seen in Alaska and the lowest daily costs were in Montana.
- The estimated cost of nursing home care for stroke in the NW region was over $1.6 million per day and $590 million per year.
- The true burden of disability due to stroke is likely to be greater than suggested here due to missing data on: level of care required after discharge from hospital for Idaho and other hospitals; people with speech and other disabilities from stroke in the community unable to participate in the survey; residents of some nursing homes; and care provided by family, friends, and home aides.

Background and Data Sources

Available data for disability due to stroke in the NW region and United States came from the hospital discharge database maintained by state hospital associations, the Behavioral Risk Factor Surveillance System (BRFSS) dataset maintained by the CDC, the Minimum Data Set (MDS) maintained by the Centers for Medicare and Medicaid Services, and the MetLife Market Survey of Nursing Home and Home Care Costs (see Appendix A). The hospital discharge database captures hospitalizations for stroke. The unit of measurement in the hospitalization database is a hospitalization and not an individual, and as such if one person was hospitalized three times in one year for stroke they will be counted three times. The BRFSS survey captures data on survivors of stroke diagnosed by a medical professional who were not currently in an institution or hospital, and were able to participate in a telephone survey. The MDS captures data on survivors of stroke living in Medicare and Medicaid certified long-term nursing home facilities. Finally, the MetLife survey captures data on average daily nursing home room costs by surveying a pre-determined number of nursing homes in each state based upon the population size. People with disabilities due to stroke not captured in these datasets include people with undiagnosed stroke in the community, people with disabilities sufficient to prevent participation in the BRFSS survey, and people living in nursing homes other than Medicare and Medicaid certified long-term nursing home facilities.

Limitations:

The following limitations of the data and analyses must be taken into account when reviewing these findings:

- Potential selection, survivor, and recall biases in the BRFSS survey (see Appendix A for details).
- People less likely to have home telephones such as poor, mobile, and ethnically diverse people may be under-represented in the BRFSS survey.
- People with stroke who are currently in-hospital, whose disabilities from stroke prevent them from participating in a telephone survey, or who have died after a stroke are not captured in the BRFSS survey.
- The number of survey respondents in this analysis corresponded to 0.51 percent of the population aged 45 years and older in the NW region in 2006 (based on population estimates from CDC Wonder).
- Potential selection biases in the hospitalization dataset include the missing hospitalization data from Idaho, the difference in co-morbidities and post-stroke survival between people with a first listed diagnosis of stroke versus any listed diagnosis of stroke, the predominance of men and lower socioeconomic groups in the Veterans Administration hospital population of which only Washington is included data in this report, and the systematic omission of data from particular types of hospitals across the NW region (see Appendix A for details).

- The potential impact on findings of repeated stroke hospitalizations by the same individual and the potential disease misclassification of stroke in the hospital database are unknown.
- The extent to which systematic differences in hospitalization data collection or data abstraction practices, or availability of services between states could explain findings is unknown.
- Potential impact of misclassification of stroke and use of patient- and family-reported data in the MDS Active Resident Information Report, and the lack of data on residents in non-Medicare and Medicaid certified nursing homes on percentage of nursing home residents with stroke is unknown.
- The size of the sample of nursing homes included in the nursing home costs survey is small and limited information is available on survey methodology, response rate, and the representative nature of the sample.
- Data should be interpreted with caution due to concerns about lack of precision and the ability to generalize to the whole population.

Chapter 5:
People who die from stroke in the Northwest

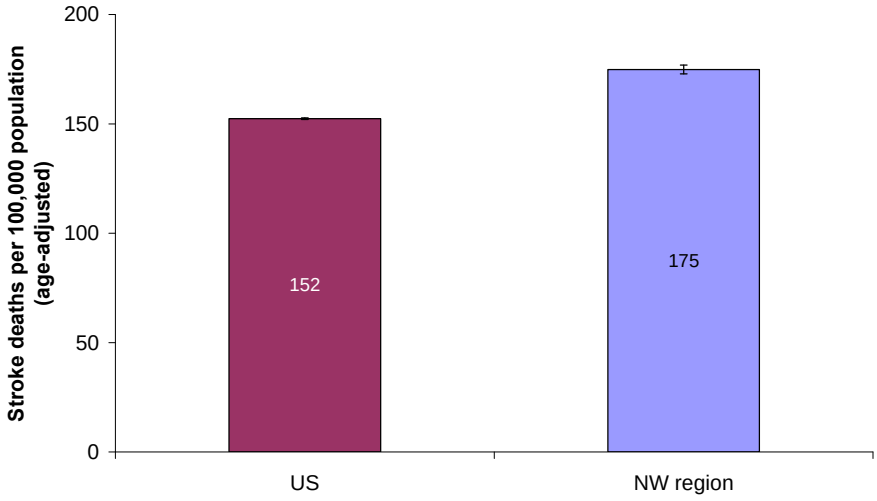
Stroke is the third most common cause of death in the United States.[28,6] In general, half of all deaths from stroke occur out of the hospital.[28]

Stroke deaths by the United States and NW Region

In the United States, an average of 155,000 people aged 45 years and older die per year from stroke. In the NW region, an average of 7,500 people aged 45 years and older die per year from stroke. Stroke accounted for seven percent of all deaths in the United States and eight percent of all deaths in the NW region in this age group.

Age-adjusted stroke death rate in adults aged 45 years and older was higher in the region at 175 people per 100,000 population than in the rest of the United States at 152 people per 100,000 population (P<0.001).

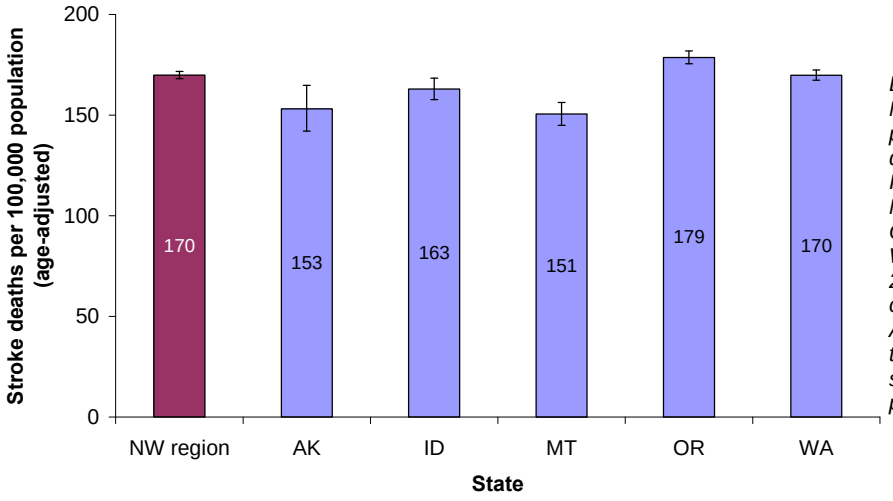
Figure 24: Stroke deaths per 100,000 population aged ≥45 years, US and NW Region, 2001-2004



Data source: Mortality and population data CDC Wonder, 2001-2004 combined. Age-adjusted to U.S. 2000 standard population.

Stroke deaths in the NW region by state

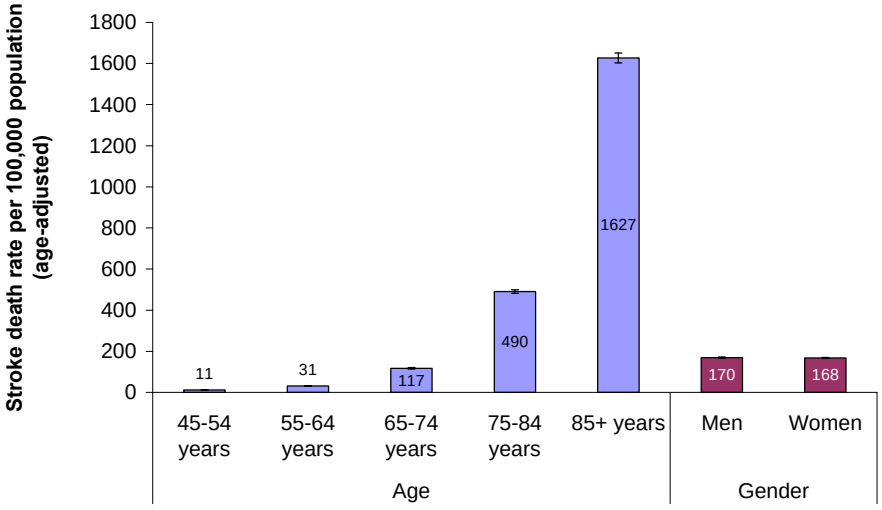
Figure 25: Stroke deaths per 100,000 population aged ≥45 years, NW Region and states, 2001-2005



Data source: Mortality and population data, Alaska, Idaho, Montana, Oregon and Washington, 2001 to 2005 combined. Age-adjusted to U.S. 2000 standard population.

Age-adjusted stroke death rates were lower in Alaska (P<0.001), Idaho (P=0.009) and Montana (P<0.001) compared with the rest of the region, while age-adjusted stroke death rates in Oregon were higher than in the rest of the region (P<0.001). Stroke death rates were similar in Washington compared with the rest of the region (P=0.95).

Figure 26: Stroke deaths per 100,000 population aged ≥45 years, NW Region by age and gender, 2001-2005



Data source: Mortality and population data Alaska, Idaho, Montana, Oregon and Washington, 2001 to 2005, combined. Data presented by gender, age-adjusted to U.S. 2000 standard population.

**Age-adjusted for gender*

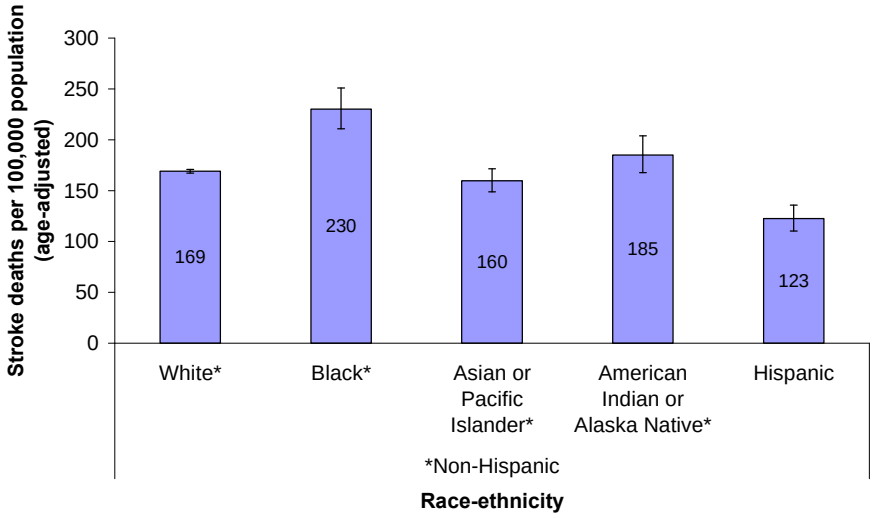
Stroke deaths in the NW region by age and gender

Stroke death rates increased steadily with increasing age (P for trend <0.001). Eleven people aged 45-54 years died from stroke per 100,000 population and this rose to 1,627 per 100,000 population in those aged 85 years and older.

Men and women had similar age-adjusted stroke death rates (P=0.44).

Stroke deaths in the NW region by race-ethnicity

Figure 27: Stroke deaths per 100,000 population aged ≥45 years, NW region by race-ethnicity, 2001-2005

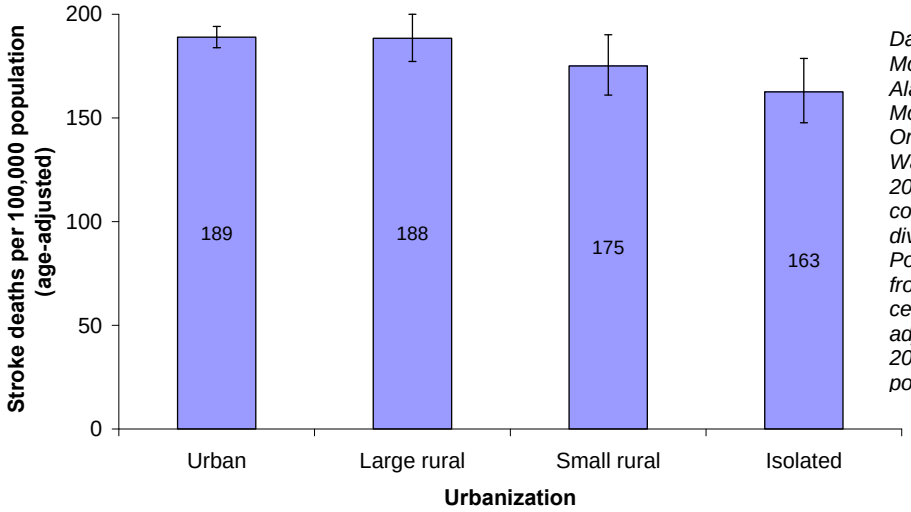


Data source: Mortality and population data, Alaska, Idaho, Montana, Oregon and Washington, 2001 to 2005 combined, except for Alaska where population data were obtained from CDC Wonder. Age-adjusted to U.S. 2000 standard population.

The age-adjusted stroke death rate per 100,000 was higher in non-Hispanic black people (P<0.001) and lower in Hispanic people (P<0.001) compared with non-Hispanic white people. Non-Hispanic Asian or Pacific Islanders (P=0.05) and non-Hispanic American Indian or Alaska Native people (P=0.01) had a similar age-adjusted stroke death rates to non-Hispanic white people.

Stroke deaths in the NW Region by urbanization

Figure 28: Stroke deaths per 100,000 population aged ≥45 years, NW region by urbanization, 2001-2005



Data source: Mortality data, Alaska, Idaho, Montana, Oregon and Washington, 2001-2005 combined, divided by five. Population data from 2000 U.S. census. Age-adjusted to U.S. 2000 standard population.

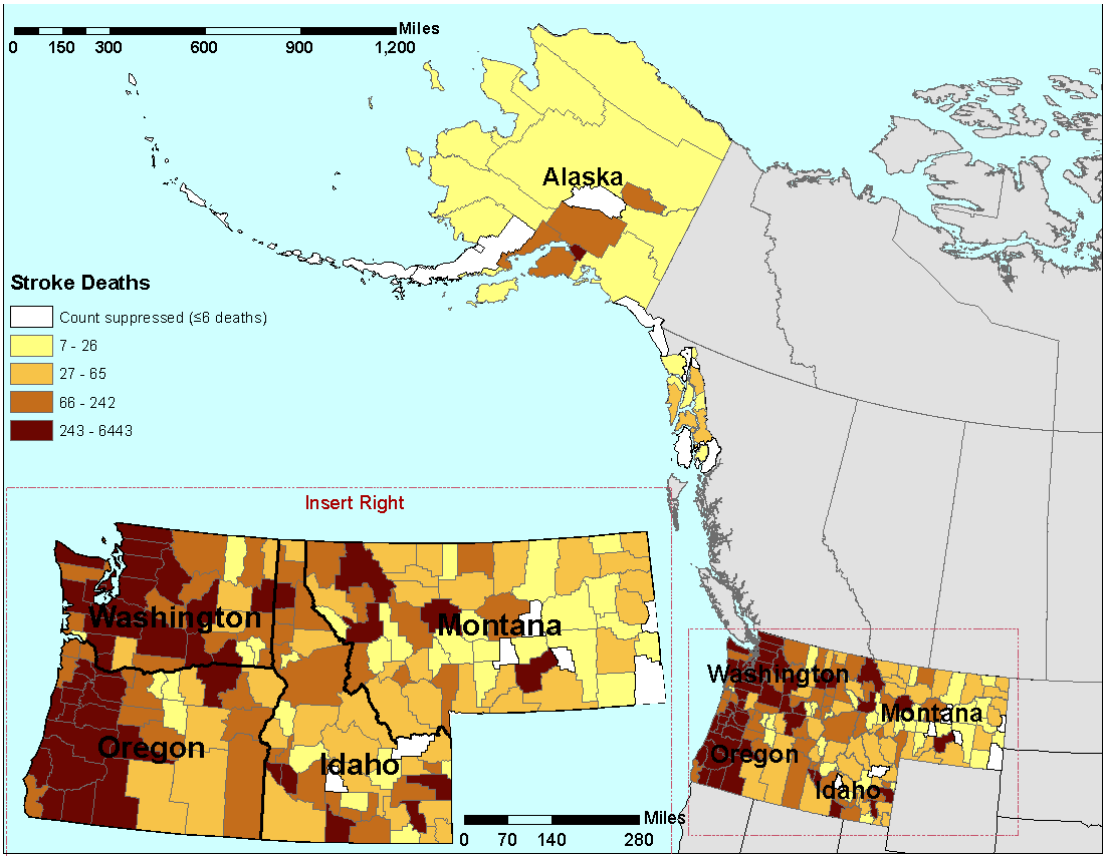
In the NW Region, it was unclear whether age-adjusted stroke death rates were related to the degree of urbanization of area of residence (P for trend=0.08). The potential impact of using 2000 population data with 2001-2005 death data (see Appendix A for details), however, was unknown and the relationship between stroke death rate and urbanization deserves further exploration.

Stroke death counts in the NW region by county

In the NW region, the number of stroke deaths by county of residence from 1999 through 2005 combined ranged from seven to 6,443 in people aged 45 years and older. Stroke death counts from 15 counties were suppressed as they included fewer than seven deaths during the seven-year period.

The counties with the highest number of stroke deaths matched broadly with areas of high population, and tended to be along the Pacific coast of Washington and Oregon.

Map 5: Regional map of stroke death counts by county, 2001-2006



Data source: Mortality and population data Alaska, Idaho, Montana, Oregon and Washington, 1999 to 2005 combined.

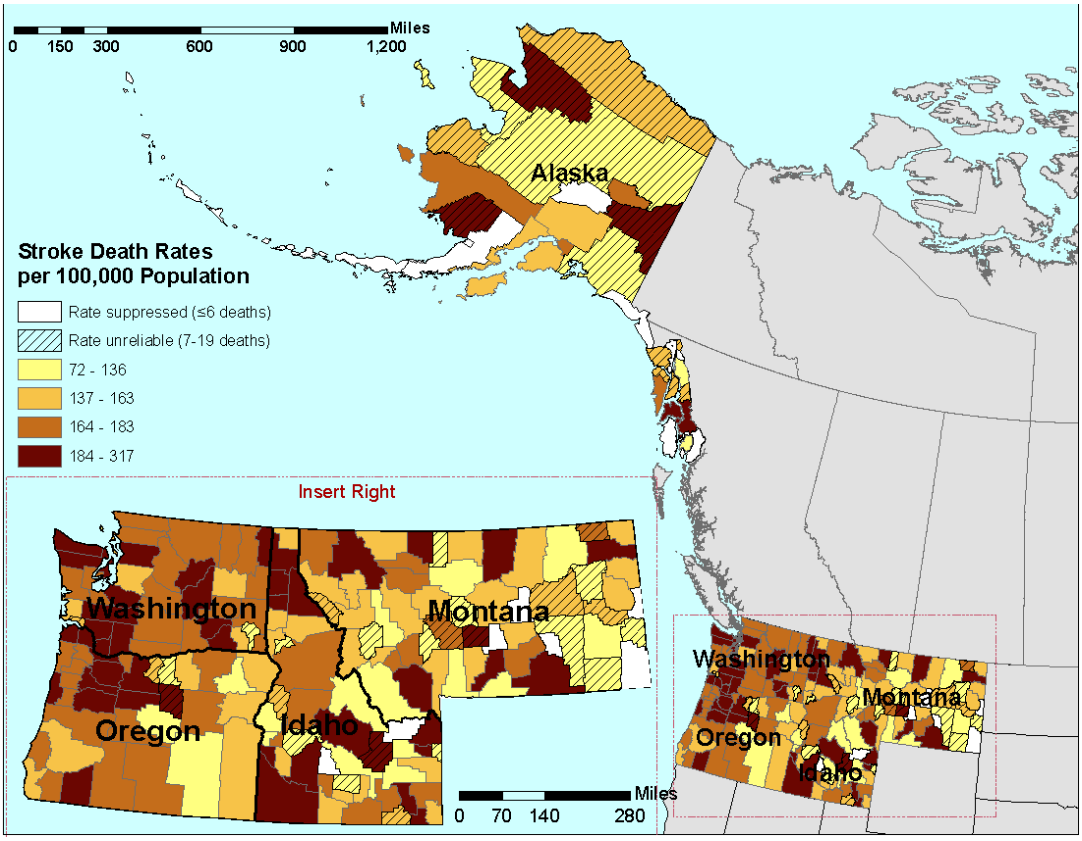
Stroke death rates in the NW region by county

In the NW region, age-adjusted stroke death rates in people aged 45 years and older by county ranged from 72 to 317 per 100,000 population. Stroke death rates from 51 counties were suppressed or considered unreliable as they were based on fewer than 20 deaths during the seven-year period.

The counties with the highest age-adjusted stroke death *rates* included both densely populated and sparsely populated areas. This was in contrast to the map of stroke deaths *counts* (previous page), where stroke death counts tended to align with the population size. Furthermore, between the contiguous states in the region, although there appeared to be differences in age-adjusted stroke death rates between bordering counties that were along state lines, statistical tests were not performed due to time constraints. It was unknown, therefore, if these death rates were truly different from each other or from the stroke death rate in the rest of the region.

Age-adjusted stroke prevalence was not assessed by county due to small sample size. Therefore, it is unknown if there is a relationship between stroke death rates and stroke prevalence by county.

Map 6: Regional map of stroke death rates by county, 2001-2006



Data source: Mortality and population data, Alaska, Idaho, Montana, Oregon and Washington, 1999 to 2005 combined. Age-adjusted to U.S. 2000 standard population.

Key Points

- In the NW region, 7,500 people aged 45 years and older die from stroke each year, and stroke accounted for one in twelve of all deaths in this age group.
- Stroke death rates in adults aged 45 years and older were higher in the NW region (175 per 100,000 population) compared with the rest of the United States (152 per 100,000 population).
- Stroke death rates in adults aged 45 years and older were lower in Alaska, Idaho and Montana, and higher in Oregon, than in the rest of the NW region. Stroke death rates in Washington were similar to that of the rest of the NW region.
- Populations aged 45 years and older with the highest stroke death rates included older adults and non-Hispanic black people.
- Hispanic people aged 45 years and older had a lower stroke death rate compared with non-Hispanic white people.
- Stroke death rates were similar in men and women aged 45 years and older.
- It was unclear if stroke death rates in adults aged 45 years and older were different in urban and rural areas in the NW region.
- Stroke death rates in adults aged 45 years and older in the NW region may have differed between counties that border each other along state lines, and high death rates were observed in both urban and rural counties.

Background and Data Sources

Available data for death due to stroke in the NW region and United States came from mortality databases maintained by each state's Vital Statistics offices and from CDC Wonder maintained by the CDC (see Appendix A). These databases were based on information abstracted from death certificates and should capture almost all deaths. For the purposes of this report, underlying cause of death was used to identify stroke deaths.

Limitations:

The following limitations of the data and analyses must be taken into account when reviewing these findings

- Use of underlying cause of death from stroke versus any listed cause of death from stroke may under-estimate the number of stroke deaths as many stroke-related deaths are reported with an underlying cause of death of atrial fibrillation or other condition that can lead to stroke and could lead to selection bias if people with an underlying cause of death from stroke are different from people with any listed cause of death from stroke.
- Causes of death are reported by individual physicians and coroners, and reporting practices may vary by location/individual. Agreement between neurologists on underlying cause of death due to stroke can be quite poor, and the potential impact of the misclassification of stroke as an underlying cause of death is unknown.
- Potential impact of the misclassification of race and ethnicity due to reliance on observation of the deceased instead of collecting data from next of kin (which tends to disproportionately affect American Indian or Alaska Native, Asian and Hispanic groups) is unknown.
- Death data were unavailable by zip code in Alaska and the potential impact of using the most populous zip code within a community to assign deaths at the community level to a zip code is unknown.
- The extent to which systematic differences in death data collection or data abstraction practices between states could explain findings is unknown.

Chapter 6:
Conclusion

Stroke can drastically reduce an individual's quality of life and create substantial social and financial strain on family, friends, and society. The results of this report highlight the need for high quality stroke care on both a statewide and regional level. Specifically, the high stroke death rate and health inequities seen across the region demonstrate the need to work towards the provision of high quality stroke care in communities in the region. The NWRSN will work towards leveraging resources in the NW region to achieve this common aim. The following text describes the most important findings and areas that require further exploration.

NW region compared to United States: Higher stroke death rates in region; lower prevalence of known risk factors

The percentage of adults aged 45 years and older who reported having had a stroke was similar in the NW region and the rest of the United States, yet stroke death rates were higher (175 per 100,000 in the NW region compared to 152 per 100,000 in the rest of the United States). Adults aged 45 years and older in the NW region had lower rates of current smoking, diagnosed high blood pressure, diagnosed diabetes, diagnosed heart disease, and multiple stroke risk factors compared to the rest of the United States. However, the data on risk factors presented here are self-reported, and data on the prevalence of undiagnosed, risk factors in the NW region compared to the United States were unavailable at this time. The true prevalence, therefore, of stroke risk factors (diagnosed and undiagnosed combined) in the population is unknown. If the stroke death rate is indeed higher in the NW region despite a true lower prevalence of risk factors compared with the rest of the United States, these findings would warrant further exploration.

Possible reasons for the higher stroke death rate in the NW region compared with the rest of the United States may include less convenient and less regular care from primary care providers, due to the more rural nature of the region than much of the United States. Access to acute care processes such as timely tPA, also likely to be poorer in rural versus urban America, are more likely to affect the disability rates than death rates, but clinical evidence is inconclusive at this time. However, the diagnosis and control of risk factors will impact stroke death rates, as people with undiagnosed or poorly controlled risk factors are more likely to die, than those who are able to manage them. Unfortunately, it was difficult to assess whether poorer control of risk factors explains the higher death rate observed in the NW region due to lack of data. In this report, hospitalization rate and death rate due to stroke were unrelated to the degree of urbanization. However, there was insufficient evidence to rule out rural geography as a potential explanation for the high stroke death rate in the NW region. Studies in Montana, Idaho, and Wyoming have reported increased barriers to stroke recognition and treatment in rural and frontier areas versus urban areas.[2, 29] Information to help answer some of these questions will be available shortly from the NWRSN Needs Assessment, which includes an assessment of the acute stroke care needs in hospitals.

Systematic differences in data collection methods were unlikely to explain the differences in both prevalence of stroke risk factors and death rate between the NW region and the United States, because the source of prevalence data (CDC core BRFSS) were collected in a standard manner in all states. In addition, death data for both the United States and NW region for this analysis were taken from CDC Wonder. Death certificate completion varies by individual funeral director, physician, and coroner. However, it is unlikely that individuals in the region completed them differently than those in the rest of the United States. Likewise, differences in population demographic characteristics between the NW region and the rest of the United States were unlikely to explain these findings. The lower percentage of risk factors in the NW region versus the rest of the United States remained after differences in age, sex, race-ethnicity, education, and income were taken into account. At least in the case of race-ethnicity, as the overall United States stroke death rates tends to be higher in non-Hispanic black populations[30], the smaller non-Hispanic black population in the NW region would be more likely to lead to a lower, rather than higher, regional stroke death rate.

Health disparities and inequities

In the NW region, both stroke risk factors and stroke were more common in groups with lower income and less educational attainment. Prevalence of stroke risk factors and stroke and stroke hospitalization rate were more common in men than in women. Prevalence of stroke risk factors, prevalence of stroke, stroke hospitalization rate and stroke death rate were more common in older adults. Also, prevalence of stroke risk factors and stroke death rate were more common in the non-Hispanic black population, and prevalence of stroke risk factors and stroke were more common in the non-Hispanic American Indian or Alaska Native population than in the non-Hispanic white population. A portion of these differences are associated with non-modifiable factors, such as aging and genetic predisposition, or by behaviors within the control of the individual. Yet to a large degree, they are driven by socioeconomic and political forces that determine social position and ease of maintenance of healthy behaviors. Social position also influences exposure to risk factors (chronic stress and racial discrimination) and resources to buffer health risks (financial resources, social support, social capital, and health care). Because exposure to health risks and access to protective resources are not distributed equally, the resulting health disparities we observe may represent issues of equity. Although the NWRSN is not able to address all aspects of these inequities, it will target interventions and engage the stroke community to help reduce stroke risk, improve quality of care, and address discriminatory practices in health care and services.

Geographical Differences: Counties along state borders

Northwest regional county-level stroke hospitalization and death rate maps suggested there may be differences in hospitalization and death rates between counties bordering one another over state lines within the region, although this has yet to be confirmed by statistical tests. One might presume that bordering counties would have similar hospitalization and death rates, but this did not appear to be the case. Possible reasons could include differences in access to EMS, pre-hospital care, the location of stroke centers, and the existence, or lack of, dispatch/transport protocols between counties as being partly responsible for these differences. Other possibilities include differences in population demographics, lack of insurance, and the location of urban settlements.

Rural and urban differences: NW regional vs. United States

In this report, no clear differences were observed in stroke hospitalization and death rates between urban and rural areas. However, this may have been due to the lack of available data, such as 2001-2005 population data by zip code, and sophisticated geographical modeling resources at the time of this report. It is well-known that timely medical treatment after onset of stroke symptoms can prevent and/or minimize disability, reduce the length of hospital stays, and prevent death. Areas with greater access to medical care may have a higher likelihood of providing timely medical care, whether through the creation of more primary stroke centers, or using telehealth (a method of providing real-time healthcare from a distance, using telephones, videoconferencing, digital imaging, and other technology that enables clinicians to assess, diagnose, and treat patients in remote areas) to link hospitals to needed stroke teams. Part of the work of the NWRSN will be devoted to exploring and developing interventions, such as distance learning trainings and telestroke (a category of telehealth that focuses on providing timely acute stroke care), to increase quality stroke care and support personnel currently involved in providing care.

Further exploration warranted

This report is the first to address stroke in the Pacific NW region of the United States. This marks the beginning of a process to gather quality and informative data to help improve stroke care in the region and guide the work of the Northwest Regional Stroke Network. Many findings in this report warrant further exploration and research, as have already been outlined in previous sections. Only when a complete picture of stroke care is provided can the most effective interventions take place to meet the identified needs in the region. Areas of continued research and need include hospitalization data available for all states, prevalence of stroke risk factors and stroke by urbanization, access to primary care providers, and uncontrolled and undiagnosed risk factors and their effect on stroke incidence and death.

Appendix A:
Technical documentation

Outline:

I. Data sources

Data sources in alphabetical order are as follows:

- Behavioral Risk Factor Surveillance System
- Centers for Disease Control and Prevention (CDC) Wonder
- Death Certificate System
- Healthy People 2010
- Hospitalization data
- MetLife Market Survey of Nursing Home and Home Care Costs
- Minimum Data Set Active Resident Information Report
- National Hospitalization Discharge Survey
- Population data
- Rural-Urban Commuting Area codes

II. Data analysis

- Statistical software
- Percentage of adults with stroke risk factors, stroke or limitations in activities: BRFSS analyses
- Hospitalization and death counts, rates and hospital charges: Hospitalization and mortality analyses
- Percentage of nursing home residents with stroke and cost of nursing home care: Nursing home analysis
- Geographic Information Systems (GIS) mapping: Hospitalization and death county maps
- Counts and rates
- Age-adjustment of percentages and rates
- 95 percent Confidence intervals
- P-values and statistical testing of "significance"

Behavioral Risk Factor Surveillance System (BRFSS)

Description: The Behavioral Risk Factor Surveillance System (BRFSS) is an annual nationwide telephone survey of adults aged 18 years and older living in the community related to medical conditions, risk behaviors, and health practices. It is funded by the Centers for Disease Control and Prevention (CDC) and administered by health departments in each state using standardized protocols.

Collection: Households are selected by random-digit dialing, and when reached, one adult from each household is randomly chosen to participate. Interviews are conducted in Spanish and English. Data on the same core set of questions are collected from each state; however, these core questions may differ each year. In addition, states may add to the CDC core question with optional survey modules.

Definitions:

- Stroke is defined as ever being told by a doctor, nurse or other health professional you have had a stroke. This definition of stroke does not include Transient Ischemic Attacks (TIA).
- Heart disease is defined as ever being told by a doctor, nurse, or other health professional you have had a myocardial infarction, angina, or coronary heart disease.
- High blood pressure is defined as ever being told by a doctor, nurse or other health professional you have had high blood pressure. High blood pressure only during pregnancy and pre-hypertension are not included within this definition of high blood pressure.
- Diabetes is defined as ever being told by a doctor that you have diabetes. Diabetes only during pregnancy and pre-diabetes are not included within this definition of diabetes.
- Smoking is defined as currently versus formerly/never smoking, where currently smoking is both the smoking of 100 or more cigarettes in a lifetime and the current smoking of cigarettes every day or some days.
- Race is defined as white, black or African American, Asian, Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, and other. In addition, participants with more than one race were asked to report their preferred race.
- Ethnicity is defined as Hispanic (including Latino/a) or non-Hispanic.
- Limitations in usual activities due to poor physical or mental health is defined as the number of days in the past month where poor mental or physical health prevented the carrying out of usual activities such as self-care and recreation.

Potential biases and limitations: Data are self-reported, and are subject to recall bias, survivor bias, and the potential under-reporting of socially undesirable behaviors. Recall bias relates to the difficulty in remembering historical events or past behaviors which increases over time, and survivor bias is such that some groups of people may be more likely to survive an event and are able to self-report the event than other groups of people. Both recall and survivor biases are likely to be affected by increasing age and poor health, for example, due to heart disease and stroke. Systematic omission and under-representation of certain population groups lead to selection bias. Populations not captured in the survey include people with cell phones, disabilities that prevent them from participating in a telephone survey (for example, speech disabilities due to stroke), users of phones for the deaf and people living in institutions. In addition, poorer, more mobile, and certain racial and ethnic groups less likely to have a home telephone may be under-represented. The under-representation of certain groups in BRFSS can lead to a lack of the ability to generalize the findings to the whole population. In addition, the small sample size of BRFSS respondents (the number of survey respondents in this analysis corresponds to 0.51 percent of the population aged 45 years and older in the NW region in 2006 based on population estimates from CDC Wonder), can lead to a lack of precision in prevalence of risk factors and disease in the whole population.

Weighting: Data are weighted to account for differences in probability of household selection and population characteristics, and adjusted for non-response and non-coverage of households without telephones. The population characteristics used to weight data varies by state and in the NW region include age, sex, and county/public health district.

Data: Data from Spanish and English speaking respondents were included in this report. Only data from the CDC core set of questions were used in this analysis, and as such U.S. datasets were downloaded from the CDC web site (see below). Data from the U.S. territories were excluded from this report. For more information and the data see http://www.cdc.gov/brfss/.

Centers for Disease Control and Prevention (CDC) Wonder

Description: The CDC Wonder database is maintained by the CDC. National mortality and population counts and mortality rates based on underlying cause of death are available from 1979 to 2004.

Definitions: Stroke is defined as ICD10 I60-I69 based on underlying cause of death.

Data: Stroke death counts and population counts for the United States, state and by age group were obtained from CDC Wonder for 2001-2004. In addition, population counts for 2001-2005 by age and racial-ethnic group for Alaska, and the total population count for the NW region aged 45 years and older in 2006, were also obtained from CDC Wonder. For more information and data see http://wonder.cdc.gov/.

Death Certificate System

Description: Mortality datasets are maintained by each state's Vital Statistics offices using data abstracted from death certificates. Death datasets are estimated to contain 99 percent of all deaths of state residents regardless of state of death.

Collection: Demographic data are typically collected by a funeral director from the next of kin, and cause of death is reported by a physician or a coroner. Classification and coding of data follow the National Center for Health Statistics (NCHS) guidelines. Count data based on an underlying cause of death of stroke were obtained from each state health department for analysis by year, age group, sex, race-ethnicity, urbanization of area of residence and county of residence. Count data based on an underlying cause of death of major cardiovascular disease were obtained by year. Count data were obtained from states using standardized protocols and data collection spreadsheets.

Definitions:

- Stroke is defined as ICD10 I60-I69 based on underlying cause of death. In addition, from 2005 stroke deaths include the F01 code due to a NCHS change in guidelines. This definition of stroke does not include transient ischemic attacks.
- Major cardiovascular disease is defined as ICD10 I00-I78 based on underlying cause of death.
- Race data on more than one race have been collected in recent years (exact year varies by state). However, prior to that, only one race was recorded. To assign race when more than one race is indicated, Idaho, Montana, and Washington follow NCHS guidelines and use the NCHS bridged race category. If more than one race is reported in Alaska, the first race listed is reported, unless the deceased is part Hawaiian in which case Hawaiian is reported. In Oregon, if more than one race is reported with percentages, the race with the highest percent is reported; if the percentages are equal, the first race listed is reported; and finally, if the deceased is part Hawaiian, Hawaiian is reported.

- Ethnicity is reported as Hispanic and non-Hispanic.
- County of residence is based on the address of the deceased and county of residence as reported on the death certificate.
- Urbanization of area of residence is defined as urban, large rural, small rural, and isolated based on Rural-Urban Commuting Area (RUCA) codes which were matched to death data by zip code (see description of RUCA codes below, page 68).

Potential biases and limitations: The use of underlying cause of death from stroke versus any listed cause of death from stroke may under-estimate the number of stroke deaths, as many stroke-related deaths may be reported with an underlying cause of death of a condition that can lead to stroke, for example atrial fibrillation. If the people with an underlying cause of death from stroke differ from those with any listed cause of stroke death, this could lead to selection bias. Misclassification of race and ethnicity can occur when based on observation of the deceased instead of from next of kin, and tends to disproportionately affect American Indian or Alaska Native, Asian, and Hispanic groups. As causes of death are reported by individual physicians and coroners, reporting practices can vary by location/individual. Agreement between neurologists on underlying cause of death due to stroke can be quite poor,[31] and the potential impact of the misclassification of stroke as an underlying cause of death is unknown. In lieu of death data by zip code in Alaska, community level death data were used to assign zip code based on the most populous zip code within a community, which was then used to assign RUCA code. For more information for each state see:

- Alaska (http://www.hss.state.ak.us/dph/bvs/data/default.htm)
- Idaho (http://www.healthandwelfare.idaho.gov/site/3457/default.aspx)
- Montana (http://www.dphhs.mt.gov/statisticalinfomration/vitalstats/index.shtml)
- Oregon (http://www.dhs.state.or.us/dhs/ph/chs/data/death/death.shtml)
- Washington (http://www.doh.wa.gov/ehsphl/chs/chs-data/death/deatmain.htm)

Healthy People 2010

Description: *Healthy People 2010* are national health objectives for 2010 and lie within the U.S. Department of Health and Human Services. The objectives used in this report include:

- Objective 12-9: Reduce the proportion of adults aged 20 years and older with high blood pressure.
- Objective 27-1: Reduce tobacco use by adults aged 18 years and older.
- Objective 5-3: Reduce the overall rate of diabetes that is clinically diagnosed in people of all ages.
- Objective 12-07: Reduce stroke deaths in people of all ages.

Objectives are age-adjusted to the 2000 U.S. standard population. For more information and objectives see http://www.healthypeople.gov/.

Hospitalization Data

Description: Inpatient hospital discharge datasets are maintained by hospital associations in Alaska, Montana, Oregon, and Washington. No data are available from Idaho.

Collection: Hospital databases in each state are described in Table 4, page 54. In brief, data are voluntarily submitted to the hospital association by participating hospitals in Alaska and Montana, and as such not all hospitals necessarily participate in the database. In contrast, reporting by state-licensed hospitals is mandatory in Washington and Oregon. Typically, hospitals abstract data from the billing form. Since hospitalizations, and not specific individuals, are reported, the same individual could contribute several hospitalizations to the database in a given year.

Hospitalizations were restricted to state residents, and in most cases (except Montana) included state residents hospitalized in other selected states (see Table 4, page 54). Count data based on first-listed diagnosis of stroke were obtained from each state health department for analysis by year, age group, sex, urbanization, level of care required on discharge from hospital, and county. Count data based on first-listed diagnosis of major cardiovascular disease were obtained by year. In addition, data were obtained on total length of stay days, range of length of hospital stay, total hospital charges, total hospital days with known charge information, and total number of hospitalizations with known charge information. Count data on hospitalizations by zip code (thus urbanization) and charge data were not available from Montana (see Table 4, page 54). Count data were obtained from states using standardized protocols and data collection spreadsheets.

Definitions:

- Stroke is defined as ICD9-CM codes 430-438 based on first-listed diagnosis at hospitalization. This definition of stroke includes transient ischemic attacks.
- Major cardiovascular disease is defined as ICD9-CM codes 390-448 based on first-listed diagnosis at hospitalization.
- Length of hospital stay is defined as discharge date minus admission date and any leave of absence days.
- Level of care required on discharge from hospital (location patient was discharged to after hospital inpatient stay) was classified as home for self-care (routine), home with care, skilled nursing facility, dead and other. Skilled nursing facilities are defined as Medicaid and Medicare certified skilled nursing facilities. Discharge to an inpatient rehabilitation facility, hospice, psychiatric hospital, federal hospital, other short- or long-term facility and against medical advice are included in the 'other' category.
- Urbanization of area of residence was defined as urban, large rural, small rural and isolated based on RUCA code which were matched to hospitalization data by zip code (see description of RUCA codes below, page 68).
- County of residence was assigned based on zip code. See WA-DOH guidelines (http://www.doh.wa.gov/HWS/doc/AppendixB2007.pdf).

In the case of zip codes that crossed county boundaries (approximately seven percent in Washington), hospitalizations in these zip codes were assigned to the county with the highest population. If the population was similar in each county, hospitalizations in these zip codes were assigned based on the physical location of the post office. In the case of hospitalizations with a postal box zip code (approximately two percent in Washington), county was assigned based on the physical location of the post office.

Potential biases and limitations: Potential selection biases in the hospitalization data include the lack of data from Idaho, voluntary data submission from hospitals in some states, inclusion of Veterans Affairs (VA) data from Washington state, use of first-listed diagnosis of stroke versus any listed diagnosis of stroke, and the systematic missing of data from particular types of hospitals (military, state and others) across the region. It is unknown if the hospitalization population in Idaho may be different from the hospitalization population of the other states in the NW region. Acute care hospitals self-select themselves for inclusion in the Alaska and Montana hospitals datasets, and in contrast, all State-licensed acute care hospitals in Washington and Oregon are mandated to submit data for inclusion in the dataset. Veterans Affairs hospitals tend to include predominantly male patients and, as they use a means-testing protocol (*For more details, see: www.va.gov/healtheligibility/costs*), patients from lower socioeconomic groups.

Of all hospitalizations in adults aged 45 years and older in Washington state, for example, the percentage that were male was 45 percent in CHARS (2001-2005), 96 percent in the VA (2001-2005), 57 percent in Army hospitals (2002-2005) and 50 percent in Navy hospitals (2002-2005). Data on socioeconomic status for hospitalizations were unavailable for comparison between CHARS, VA and military hospitals in Washington. The classification of stroke using first listed diagnosis of stroke is less sensitive, however, of similar specificity compared with the classification of stroke using any listed diagnosis.[32] Sensitivity in this case is a measure of how well all stroke hospitalizations are classified as due to stroke in the dataset, and as such, the lower sensitivity connected with the use of first-listed diagnosis will mean that some stroke hospitalizations will not be included in the first-listed diagnosis field and hence missed. No difference was reported in this study, in age or sex of patients between first listed- versus any listed diagnosis of stroke. However, people with stroke identified using the first listed diagnosis were found to have less co-morbid conditions and to be less likely to die within 30 days of event than patients classified using any listed diagnosis of stroke.[32] It is unknown how much the systematic missing data from particular hospitals may affect findings. Finally, the potential impact on findings of multiple hospitalizations from the same individual and the allocation of some hospitalizations to the wrong county of residence is unknown. The potential impact of varying admission and care practices in different hospitals on stroke hospitalizations and length of stay, for example, is similarly unknown.

Data: For more information about state-specific details of hospitalization datasets from which count data were obtained for this report please see:

- ***Alaska*:** http://www.ashnha.org/content/ or Alice Rarig, Alice.Rarig@Alaska.gov.
- ***Idaho:*** No hospitalization data available.
- ***Montana*:** http://www.mtha.org/ or Carrie Oser, coser@mt.gov.
- ***Oregon*:** http://www.oahhs.org/index.php or Ying Han, Ying.Han@state.or.us.
- ***Washington*:** http://www.doh.wa.gov/EHSPHL/hospdata/Chars.htm/ or Ric Ordos, Ric.Ordos@doh.wa.gov.

Table 4: State hospitalization data used in this analysis

State	Database(s) in analysis	Voluntary or mandatory data reporting	Hospital charges data available	Zip-coded data available	Years *						Hospitals in database(s)	Hospitals not in database(s)	Out-of-state hospitalizations included from which states
					2001	2002	2003	2004	2005	2006			
Alaska	Alaska State Hospital and Nursing Home Association (ASHNHA)	Voluntary †	Yes	Yes	X	X	X	X	X	X	State-licensed acute care hospitals, Alaska Native Medical Center (a tertiary hospital serving Alaska Natives), 1 military hospital	6 small tribal hospitals with ≤50 beds, 2 psychiatric hospitals, Department of Veterans Administration, one military hospital	Washington
Idaho	-	-	-	-	-	-	-	-	-	-	-	-	-
Montana	MHA - An Association of Montana Hospital Care Providers	Voluntary †	No	No	X	X	X	X	X	X	State-licensed acute care hospitals	State and federal hospitals (i.e. Indian Health Service, Department of Veterans Administration and state psychiatric hospitals)	-
Oregon	Oregon Association of Hospitals and Health Systems (OAHHS)	Mandatory †	Yes	Yes	X	X	X	X	X	X	State-licensed acute care hospitals	Indian Health Service, state psychiatric hospitals, military hospitals, Department of Veterans Administration	Southwest Washington

					Years *								
State	Database(s) in analysis	Voluntary or mandatory data reporting	Hospital charges data available	Zip-coded data available	2001	2002	2003	2004	2005	2006	Hospitals in database(s)	Hospitals not in database(s)	Out-of-state hospitalizations included from which states
Washington	Comprehensive Hospital Abstract Reporting Systems (CHARS)	Mandatory	Yes	Yes	X	X	X	X	X	X	State-licensed acute care hospitals, Department of Veterans Administration, Madigan Army Medical Center, Navy Hospital Bremerton	Indian Health Service, state psychiatric hospitals	Oregon
	Department of Veterans Administration (VA)	Mandatory †	No	Yes	X	X	X	X	X	-			
	Military	Mandatory †	No	Yes	-	X	X	X	X	-			
	Healthcare Cost and Utilization Project (HCUP)	Mandatory	Yes	Yes	X	X	X	X	-	-			

** 2006 data only included in county-level GIS analysis, all other analysis included 2001-2005 data only*
† Data obtained through voluntary cooperative agreements with the State Departments of Health

MetLife Market Survey of Nursing Home and Home Care Costs

Description: The MetLife Market Survey of Nursing Home and Home Care Costs is conducted by MetLife Mature Market Institute for Metropolitan Life Insurance Company.

Collection: Nursing homes were sampled from one capital/most populated city from states with a population of less than three million, from two most populated cities/areas representative of the state from states with a population of between three and ten million, and from three most populated cities/areas representative of the state from states with a population of greater than ten million. Data were collected by telephone from ten nursing homes or 15 percent of nursing homes within each city/area. Nursing homes had to be licensed, provide skilled and custodial care, and offer a private-pay rate for long-term care. In total, data from 1,116 nursing homes were included in the survey across the United States.

Data: Data from the September 2006 survey were used for this analysis. For more information see http://www.metlife.com/Applications/Corporate/WPS/CDA/PageGenerator/0,4773,P8895,00.html.

Minimum Data Set Active Resident Information Report

Description: The Minimum Data Set (MDS) is maintained by the Centers for Medicare and Medicaid Services. All Medicare and Medicaid certified long-term care facilities are required to complete a Resident Assessment Instrument (RAI) for all residents residing in the facility for more than 14 days regardless of age, diagnosis, length of stay or payment category. The MDS Active Resident Information Report summarizes information for all residents with an assessment transaction within the last 180 days that was not a discharge.

Collection: The RAI must be conducted or coordinated by a registered nurse and is completed using information from the resident's record, nursing facility staff, resident's physician, licensed professional staff, resident, and resident's family.

Definitions:

- Stroke is defined as a physician-documented diagnosis of cerebrovascular accident in the clinical record that currently affects the resident's functioning or care plan.

Potential biases and limitations: Potential selection biases in the MDS include the exclusion of non-Medicare and Medicaid certified nursing facilities, which may be more likely to contain patients of higher socioeconomic status. However, as few facilities are not Medicare and Medicaid certified, this should have little impact on our findings. The exclusion of patients residing in the care facility for less than 14 days may lead to selection bias, as these patients may be either younger or have less serious medical conditions and thus be discharged soon after admission, or they may be older and have more serious medical conditions and die soon after admission. The potential impact of the use of patient- or family-reported data on findings is unknown.

Data: Data from the First Quarter 2007 report were used for this analysis. For more information and the report see http://www.cms.hhs.gov/MDSPubQIandResRep/.

National Hospitalization Discharge Survey (NHDS)

Description: The National Hospital Discharge Survey (NHDS) is a national probability survey of inpatients discharged from non-federal short-stay hospitals conducted annually by the CDC.

Collection: Only hospitals with an average length of stay for all patients of 30 days or less, general hospitals, or children's general hospitals are included in the survey. Federal, military, and Department of Veterans Administration hospitals, as well as hospital units of institutions (such as prison hospitals), and hospitals with fewer than six beds, are excluded. Similar to the state hospitalization datasets (described above, page 54), hospitalizations, and not specific individuals, are the unit of measurement, so the same individual could contribute several hospitalizations to the survey in a given year. In 2005, data were collected from a sample of approximately 375,000 inpatient records acquired from a national sample of 444 hospitals, and were weighted to account for survey design.

Definitions:

- Stroke is defined by a first-listed diagnosis of cerebrovascular disease using ICD9-CM codes 430-438.

Data: NHDS datasets suitable for analyses were unavailable, so information was taken from the 2005 National Hospital Discharge Survey report produced by the National Center for Health Statistics (2006 National Hospital Discharge Survey). Hospitalization rates for age groups 45-64 years and 65 years and older were calculated using U.S. Census Bureau post-censal estimates based on the 2000 U.S. Decennial Census of the civilian population as of July 1, 2005. For more information and the report see http://www.cdc.gov/nchs/about/major/hdasd/nhds.htm.

Population Data

Description and collection: Population counts by age group from each state in the NW region for people aged 45 years and older were obtained by sex and race-ethnicity from 2001-2005 combined for the state-level hospitalization and death rate analyses. In addition, population data from each state in the NW region for people aged 45 years and older were obtained by age group and county from 2001-2006 combined for the county-level hospitalization rate analysis and from 1999-2005 combined for the county-level death rate analysis. These data were used as denominators in the calculation of age-specific hospitalization and death rates per 100,000 population, and age-adjusted hospitalization and death rates by sex, race-ethnicity, county and level of care required on discharge from hospital per 100,000 population. State population counts for all years beginning in 2000 were estimated from post-censal estimates based on the 2000 U.S. Decennial Census (http://www.census.gov/). State population counts for 1999 were estimated from post-censal estimates based on the 1990 U.S. Decennial Census (http://www.census.gov/). Population data by county were compiled from census block level data. Population data by race-ethnicity were compiled based on NCHS guidelines using the NCHS bridged race category to assign race when more than one race was reported. Population data, from which count data were drawn, were compiled by the following agencies or contractors in each state:

- ***Alaska*** (Alaska Department of Labor and Workforce Development, Research and Analysis, http://almis.labor.state.ak.us/?PAGEID=67&SUBID=115)
- ***Idaho*** (Idaho Department of Health and Welfare, Bureau of Vital Records and Health Statistics)

- ***Montana*** (Montana Department of Public Health and Human Services, Business and Financial Services Division, Office of Vital Statistics)
- ***Oregon*** (Portland State University Population Research Center, National Center for Health Statistics)
- ***Washington*** (Washington State Department of Health, Vista Partnership, Krupski Consulting, December 2007)

Potential biases and limitations: Potential selection bias in population data include the under-representation of homeless people, the urban poor people living over commercial addresses and undocumented people. In addition, people living in institutions such as psychiatric hospitals and prisons may be omitted from some population estimates, as are some members of large households due to only data from six household members being counted per household in the 2000 census. Moreover, active military personnel may be counted as part of the population in areas other than where they reside. Finally, another limitation of the use of population data are that college students may be counted in the areas in which they attend college even though health events may be recorded at their parent's address.

Data: State population counts by age group and race-ethnicity from 2001-2005 combined were unavailable in Alaska at the time of this report, and Alaska population counts by race-ethnicity were obtained from CDC Wonder for these years. State population counts by age group and zip code from 2001-2005 combined were unavailable from each state at time of analysis, and population counts were obtained from the U.S. 2000 Decennial Census for the calculation of hospitalization and death rates per 100,000 population by urbanization based on hospitalization and death counts from 2001-2005 combined. Population counts by age group used to calculate stroke death rates per 100,000 population based on death counts from CDC Wonder for 2001-2004 by year, state and age group were obtained from CDC Wonder. For more information for each state see:

- ***Alaska:*** Alaska Department of Health and Social Services, Section of Chronic Disease Prevention and Health Promotion, Surveillance and Evaluation Team, phone (907) 269 8025.
- ***Idaho:*** Idaho Department of Health and Welfare, Bureau of Vital Records and Health Statistics, phone (208) 334 6571.
- ***Montana:*** Montana Department of Public Health and Human Services, Public Health and Safety Division, Cardiovascular Health Program, phone (406) 444 4002.
- ***Oregon:*** Oregon State Department of Human Services, Public Health Division, Center for Health Statistics, phone (971) 673 1190/1180.
- ***Washington:*** Washington State Department of Health, Center for Health Statistics, phone (360) 236 4324.

Rural-Urban Commuting Area codes (RUCA)

Description: Rural-Urban Commuting Area (RUCA) codes are a collaborative project between the Health Resources and Service Administration Office of Rural Health Policy (ORHP), the Department of Agriculture Economic Research Service (ERS), and the Washington, Wyoming, Alaska, Montana, Idaho (WWAMI) Rural Health Research Center.

RUCA codes are based on population density and population work commuting patterns, and classify rural-urban commuting areas into 33 different categories ranging from very urban to very isolated. RUCA codes are available at both the census tract and zip code level. In this report, RUCA codes are used to define urbanization.

Definitions:

- Urbanization is classified as urban, large rural, small rural and isolated by using RUCA codes and the standardized coding framework from the RUCA Web site (see below) to collapse the 33 categories of RUCA into these four categories of urbanization.

Potential biases and limitations: The effect of potential misclassification of urbanization in some areas due to the use of RUCA codes based on zip code and not at the census tract level is unknown; however, it is unavoidable as hospitalization and death data at the census tract level were unavailable at time of analysis.

Data: In this report, version 2.0 RUCA codes at the zip code level are used to define urbanization, which are based on 2000 U.S. Decennial Census data and 2004 zip code data. For more information and the data see http://depts.washington.edu/uwruca/.

II. Data analyses

Statistical software

Data were analyzed primarily using Stata version 9.2 (http://www.stata.com/). Supplemental analyses were performed using Microsoft Office Excel version 2003 (http://office.microsoft.com/en-us/excel/) and the Joinpoint Regression Program version 3.0 (http://srab.cancer.gov/joinpoint/). Stat/Transfer version 9 (http://www.stata.com/products/transfer.html) was used to convert MS Excel data files to Stata datasets for analysis.

Percentage of adults with stroke risk factors, stroke or limitations in activities: BRFSS analyses

Data used in analysis

Percentage of adults aged 45 years and older with risk factors for stroke, stroke and limitations in usual activities in those with stroke were analyzed using BRFSS data. To minimize the likelihood of encountering small numbers in the analysis, multiple years of data were combined for analysis. Table 5 shows the year data were collected for each of the main (dependent) variables used in this analysis.

Table 5: Data from the Behavioral Risk Factor Surveillance System (BRFSS) dataset used in this analysis *

Variable	Year			
	2003	2004	2005	2006
People with heart disease	-	-	X	X
People with diabetes	-	-	X	X
People with high blood pressure	X	-	X	-
People who currently smoke	-	-	X	X
Number of coexisting stroke risk factors	-	-	X	-
People with stroke	-	-	X	X
Limitations in usual activities in people with stroke	-	-	X	X

** Data on age, sex, race-ethnicity, education and income are collected every year*

In brief, the risk factor analysis was performed using data from 2005 and 2006 combined for heart disease, diabetes, and smoking; 2003 and 2005 combined for high blood pressure; and from 2005 for number of coexisting risk factors. The stroke and limitations in usual activities analyses were performed using data from 2005 and 2006 combined. The use of data from different years for different risk factors was necessary because high blood pressure data are only collected every two years. Data on age, sex, race-ethnicity, education, and income (considered covariates or independent variables in this analysis) are collected every year.

Calculation and coding of variables in analysis

- Percentage of adults aged 45 years and older with risk factors for stroke was calculated as the number of people aged 45 years and older with risk factors divided by the number of adults aged 45 years and older who reported either having or not having those risk factors (combined) multiplied by 100. Responses of "Don't know" were coded as missing. Percentages of adults aged 45 years and older with coexisting stroke risk factors, stroke or with limitations in usual activities were calculated in a similar fashion.
- The number of coexisting stroke risk factors was calculated by assigning a value of one to each of the four risk factors explored in this report (high blood pressure, heart disease, diabetes, and current smoking) and by summing these values to give a number between zero and four. The coexistence of two or more risk factors was classified into two categories as zero or one risk factor (combined) and two through four risk factors (combined).
- Limitations in usual activities due to poor physical or mental health in adults who had had a stroke was classified into two categories as zero days in the past month and as one or more days in the past month. The former group included respondents who reported no days of poor mental or physical health in the past month.
- Age groups in this analysis were classified as 45-54 years, 55-64 years, and 65 years and older.

- Race-ethnicity groups, based on single or preferred race (as appropriate), were classified as non-Hispanic white, non-Hispanic black, non-Hispanic Asian or Pacific Islander, non-Hispanic American Indian or Alaska Native, and Hispanic. People who reported "other" or no preferred race were coded as missing.
- Education was classified into three categories as high school or less, some college or college graduate, or more.
- Income was classified into three categories as less than $25,000, $25,000 to $49,999, and $50,000 or more.
- The 2006 population aged 45 years and older in the NW region with stroke or stroke risk factors was calculated as the total population in this age group multiplied by the percentage of adults aged 45 years and older in the NW region with stroke or stroke risk factors, as appropriate. The total population aged 45 years and older in the region (5,035,338 people) was obtained from CDC Wonder.

Statistical methods

Data were analyzed using the survey (svy) data commands in Stata, designed for complex survey samples, based upon Taylor series linearization methods. Asymmetric confidence intervals were generated based on the Student t-distribution with degrees of freedom determined by the sample survey design, and using a logit transformation. Data were weighted using the CDC weight variable (_finalwt) that accounts for the probability of selecting a household, a specific person within a household, a specific region, and a person within a specific age-gender group. In addition, data were adjusted for sample design using the sample design stratification variable (_ststr). Data analyses were restricted to adults aged 45 years and older, and data from Puerto Rico and the Virgin Islands were excluded from analyses.

Data from individual years were appended together in Stata to combine data from multiple years for analyses. Before data from individual years were combined, the stratification variable (_ststr) was concatenated with survey year. All percentages were age-adjusted to the U.S. 2000 Standard population[33] using the age groups 45-54 years, 55-64 years and 65 years and older as described below (page 61), except for age-specific percentage analyses. Statistical testing of the differences between two groups and of a trend across three or more categories of ordinal variables was performed using logistic regression. To maintain data independence, tests of the difference between the United States and the NW region were conducted as the NW region versus the United States (minus the region), and likewise, tests of the difference between the NW region and the states within the region were conducted as the state versus the region (minus the state).

Two regression models were performed (1) including data from only respondents with complete data on all potential confounding variables and adjusted for age only, and (2) including only respondents with complete data on all potential confounding variables and adjusted for age and confounding variables. Sample size was, therefore, the same in each model. The potential confounding variables considered in these analyses other than age included sex, race-ethnicity, education, and income. Age, sex, race-ethnicity, education, and income were also explored as independent variables. Models testing for one independent variable were adjusted for the remaining covariates, as appropriate.

For example, due to concerns about collinearity, models assessing trend in outcome across education categories (when stroke or stroke risk factor was the dependent variable and education was the independent variable) did not include income.

Similarly, models assessing trend in outcome across income categories (when stroke or stroke risk factor was the dependent variable and income was the independent variable) did not include education. Collinearity between education and income was confirmed in the 2005-2006 BRFSS dataset by tabulation and tests for trend. In models assessing the difference in outcome by race-ethnicity, the non-Hispanic white population was used as the reference group. The data presented in each graph are of age-adjusted percentages from model one, described above. Graphs show 95 percent confidence intervals (see description of confidence intervals on page 67) and percentages rounded to the nearest whole number. Results from model two are reported in the text, where indicated. Statistical testing of effect modification (interaction) was not performed due primarily to time constraints. However, as the main aim of this analysis was to present a single overall estimate of the effect of an exposure adjusted for several factors (essentially regardless of whether effect modification was present or not) this would not have affected the main conclusions of this report.[34]

To maintain data confidentiality and estimate reliability, suppression criteria for BRFSS percentage data include numerators of less than ten, denominators less than 50, and relative standard errors of greater than 30 percent (relative standard error = [standard error/percent] multiplied by 100). Percentages are considered unreliable when based on numerators of between ten and 30. Suppressed or unreliable percentages based on these criteria are indicated in the text.

Hospitalization and death counts, rates and hospital charges: Hospitalization and mortality analyses

Data for comparison of stroke hospitalization and death within the NW region

Hospitalization, death and population count data were obtained from each of the five states in the Stroke Network (with the exception of hospitalization data from Idaho, see above). To minimize the likelihood of encountering small numbers in these analyses, multiple years of data were combined for analyses. Hospitalization and death counts and rates at the state level were described using data from 2001-2005 combined, and at the county level using data from 2001-2006 combined (hospitalizations) and 1999-2005 combined (deaths), with population data from matching years. In addition, hospitalization charges and length of hospital stay were described using data from 2001-2005 combined.

Population at the zip code level for calculation of hospitalization and death rates by urbanization were not available from each state, and the only available data were from the 2000 census. Thus, rates of hospitalization and death by urbanization were described using hospitalization and death counts for 2001-2005 combined divided by a factor of five with population data from 2000. Finally, discrete population data do not exist for level of care required on hospital discharge because they are by their nature hospitalization data and matching population cannot be collected.

Therefore, to describe rate of level of care required on hospital discharge the same population data (from corresponding years and age groups) were used for each category of discharge status such that, for example, the population of 515,753 people aged 45-54 year in Alaska was used as the denominator for all five categories of discharge status in that age group.

Hospitalization and death age-adjusted rates for stroke per 100,000 population aged 45 years and older were calculated by region, state, county, sex, race-ethnicity (deaths only), and urbanization. Hospitalization and death counts for stroke in adults aged 45 years and older were presented by county only and were calculated by summing counts by age group within each county. Age specific hospitalization and death rates for stroke per 100,000 population aged 45 years and older were calculated for the NW region only. Age-adjusted rate of level of care required on hospital discharge for stroke per 100,000 population aged 45 years and older were calculated by region and state. Hospitalization and death rates per 100,000 population aged 45 years were age-adjusted to account for the differences in age distribution between groups (see below, page 63). All rates were age-adjusted to the U.S. 2000 Standard population, except for age-specific rate analyses.

Calculation and coding of variables

- Age groups in this analysis were 45-54 years, 55-64 years, 65-74 years, 75-84 years and 85 years and older.
- Race and ethnicity for mortality data were coded as non-Hispanic white, non-Hispanic black, non-Hispanic Asian or Pacific Islander, non-Hispanic American Indian or Alaska Native, and Hispanic. In years where multiple race data were collected, NCHS bridged race data were used from Idaho, Montana and Washington. NCHS bridged data were unavailable from Alaska and Oregon, and race data were used as recorded by these states (see above). Hospitalization data were unavailable by race and ethnicity.
- Urbanization of area of residence was classified as urban, large rural, small rural and isolated.
- Level of care required on hospital discharge (sometimes called discharge status) was categorized as home for self-care, home with care, skilled nursing facility, died and other.
- Average length of hospital stay was calculated as total length of stay days divided by total number of hospitalizations.
- Average charge per hospitalization was calculated as total charges divided by total number of hospitalizations with known charge information.
- Average hospitalization charges for stroke per year was estimated as the total number of hospitalizations 2001-2005 combined divided by five multiplied by the average hospitalization charge.

Data for comparisons of stroke hospitalization and death between the United States and NW region

Data from the National Hospitalization Discharge Survey (NHDS) were unavailable to calculate national age-adjusted hospitalization rates for people aged 45 years and older.

Therefore, national comparisons of hospitalization data were made using statistics from the 2005 NHDS report on hospitalization rate in people aged 45-

64 years and 65 years and older with hospitalization rate in these age groups in the NW region based on counts from 2001-2005 combined.

From our understanding, these statistics on national hospitalization rate by age group are not age-adjusted and therefore we presented data for the NW region as age-specific rates to allow for comparison. In the NHDS, rates are reported per 10,000 population, so these rates were multiplied by ten to convert them to rates per 100,000 population. Confidence intervals for NHDS rates of stroke hospitalizations were estimated as the rate ± 1.96 multiplied by the standard error. National comparisons between stroke deaths in the NW region and the United States were made using death and population counts obtained from CDC Wonder which were analyzed as described above. Data on deaths in the United States for 2005 were unavailable on CDC Wonder at the time of this report, and both death and population counts for the NW region and United States from 2001-2004 were obtained from CDC Wonder for analysis.

Statistical analysis

Data were analyzed using a locally adapted version of the direct standardization (dstdize) data commands in Stata. Data analyses were restricted to adults aged 45 years and older, and data counts from each state were manually appended together in MS Excel before conversion to a Stata dataset using Stat/Transfer.

Asymmetric 95 percent confidence intervals for hospitalization and death age-adjusted rates were calculated based on the gamma distribution[35] to produce valid confidence intervals even when the number of counts was small. The 95 percent confidence intervals for hospitalization and death age-specific rates were calculated based on the Poisson distribution when the number of counts was less than 100 and were based on the normal distribution when the number of counts was greater or equal to 100. Statistical testing of the differences between two groups was performed using the immediate form of the t-test (the ttesti command in Stata). To maintain data independence, tests of the difference between the United States and the NW region were conducted as the NW region versus the United States (minus the region), and likewise, tests of the difference between the NW region and the states within the region were conducted as the state versus the region (minus the state).

When assessing the difference in rates by race-ethnicity, the non-Hispanic white population was used as the reference group in t-tests. Standard deviations for use in the t-test were estimated as the standard error multiplied by the square root of the total population, where standard error was calculated by Stata. Test for trend in rates across three or more categories was assessed using Joinpoint software, which used data on rate and standard error for each category. The statistical assumptions for using Joinpoint to assess trend were that the dependent variable was normally distributed and observations were independent of each other. In addition, it was recommended that trend be assessed across at least six to ten data points. In this analysis, trend in hospitalization and death rates were assessed across five categories for age and four categories for urbanization. The low number of data points in this analysis was unavoidable.

Therefore, when assessing trend of hospitalization and death rates by age group and urbanization, the result of the Joinpoint analysis were considered alongside a visual observation of the data and the separation of confidence intervals to assess if there was sufficient evidence of a trend. Furthermore, appropriate count data were unavailable to assess if differences or trends in hospitalization and deaths rates between groups could be explained by sex, race-ethnicity, education, income, or prevalence of risk factors.

To maintain data confidentiality and estimate reliability, hospitalization and death counts of six or fewer events and rates based on counts of six or fewer events were suppressed, and rates based on counts of less than 20 events were considered unreliable. In this report, hospitalization data from one county were suppressed and data from 13 counties were considered unreliable across the NW region based on these criteria. Meanwhile, death data from 15 counties were suppressed and data from 35 counties were considered unreliable across the NW region. In maps, suppressed counts and rates were shown in maps using white shading, and unreliable rates were shown using cross-hatching.

Percent of nursing home residents with stroke and cost of nursing home care: Nursing home analysis

Data used in analysis

Data on the total number of nursing home residents and percent of nursing home residents with a diagnosis of stroke from the MDS Active Resident Information Report First Quarter 2007 were used to estimate the number of nursing home residents with a diagnosis of stroke by region and state. Data on the average daily cost of a private and semi-private room in a nursing home in the United States and regional states were abstracted from the MetLife Market Survey of Nursing Home and Home Care Costs 2006.

Calculation of variables

- Cost per day of nursing home care due to stroke in the NW region was calculated as the U.S. daily cost of a private room nursing home multiplied by the number of nursing home residents with a diagnosis of stroke.
- Cost per year of nursing home care due to stroke in the NW region was estimated by multiplying the daily cost of nursing home care for stroke in the region by 365.25 days.

Statistical analysis

Data on percentage of nursing home residents with a diagnosis of stroke in the United States and the individual states in the NW region were taken from the MDS Active Resident Information Report. Percentage of nursing home residents with a diagnosis of stroke in the region as a whole was estimated using the sum of the total number of nursing home residents and the number of nursing home residents with stroke in each state in the NW region. Ninety-five percent confidence intervals were estimated based on the normal distribution using the formula in the Washington State Department of Health Data Guidelines available at http://www.doh.wa.gov/Data/Guidelines/ConfIntguide.htm (see part 4.4).

This formula estimates the margin of error based on the total number of nursing home residents and the number of residents with a diagnosis of stroke. Symmetrical confidence intervals were estimated as the percentage of nursing home residents with stroke ± the margin of error.

Statistical testing of the differences between two groups was performed using the immediate form of the t-test (the ttesti command in Stata). To maintain data independence, tests of the difference between the United States and the NW region were conducted as the NW region versus the United States (minus the region), and likewise, tests of the difference between the NW region and the states within the region were conducted as the state versus the region (minus the state).

Standard deviations for use in the t-test were estimated as the standard error multiplied by the square root of the total population, where standard error was estimated as the margin of error divided by 1.96.

Geographic Information Systems (GIS) mapping: Hospitalization and death county maps

Hospitalization and death counts and rates (per 100,000 population) at the county level are presented as maps, created using the Geographic Information Systems (GIS) mapping ArcMap software version 9.2 (http://www.esri.com/). To generate the maps, data by county were overlaid on the NW region and the four contiguous states of Idaho, Montana, Oregon and Washington were enlarged to enhance visibility. Counties with six or fewer stroke deaths or hospitalizations (including zero counts) were suppressed to maintain data confidentiality and are shown by white shading in all four maps. In addition, counties with rates based on seven to 19 stroke deaths or hospitalizations were considered unreliable and were crosshatched in rate maps.

Counts and rates

Stroke hospitalization and death counts are a crude indicator of stroke burden and do not take into account the stroke burden as a function of the total population, for example 100 deaths among a group of 250 people as a health concern will be considered differently from 100 deaths among a population of one million people.

As such, hospitalization and death rates per 100,000 population aged 45 years and older were calculated as counts divided by the population multiplied by 100,000, using population data from corresponding years and groups.

Age-adjustment of percentages and rates

To age-adjust data means to take into account the age distribution of the population in the estimate. Age-adjustment is particularly important for factors and diseases that are strongly age-dependent and when the purpose of analysis is to compare data between groups or geographical areas. An example of an age-dependent disease is stroke which is more common in older people than in younger people. If data are not age-adjusted, it is impossible to say if one region has a higher percent of people with stroke because of a true difference between the two groups of people or if one group is simply older than the other group. Data were age-adjusted to the 2000 U.S. standard population [3333] using the following age groups: 45-54, 55-64, 65-74, 75-84, and 85 and older years (hospitalization and death rates), and 45-54, 55-64, 65 and older years (percent of people with stroke risk factors, stroke and limitations in usual activities). Age-adjusted rates were calculated by multiplying the rate for a specific age group in a given population by the proportion of people in the same age group in the U.S. 2000 standard population, and then adding the rates across age groups.

Age-adjusted percentages are calculated in a similar fashion with the additional final step of multiplying the final percent by 100.

95 percent confidence intervals

A confidence interval is a range of values within which we are reasonably confident that the true population value lies; it is a measure of the variability in the data. The confidence intervals reported in this document are 95 percent confidence intervals, meaning that in 95 out of 100 instances the confidence interval reported should include the true population value.

For example, the percent of people aged 45 years and older in Alaska with self-reported high blood pressure is estimated to be 36.1 percent; however, there is a 95 percent probability that the true value lies within 33.3 percent and 39.0 percent (Chapter 2, page 17). In this report, the 95 percent confidence intervals are shown in graphs by vertical lines which extend above and below the colored bars in graphs, and the minimum and maximum values are shown by the horizontal lines at each end. Together with p-values, within the context of study design and potential confounding and bias, 95 percent confidence intervals are used to help assess possible differences in data between groups.

P-values and statistical testing of "significance"

A p-value is generated from a statistical test of the difference between groups and test for trend across three or more categories of an ordinal variable. It indicates the strength of the evidence against the null hypothesis that there is no difference between groups. The smaller the p-value, the stronger the evidence against the null hypothesis, and in other words, the stronger the evidence of a difference between the groups being tested. A p-value of 0.05 is traditionally used as a threshold for statistical "significance." However, this value is arbitrary, and using this threshold one out of every 20 tests would yield a result considered significant at p=0.05 by chance alone.

In this report, $p<0.001$ was used as a guideline, and not a threshold, together with sample size, magnitude of the difference between groups and other factors when considering if there was sufficient evidence to reject the null hypothesis.

For example, age-adjusted prevalence of stroke in the NW region was considered similar in men and women when the total sample size was 51,000 respondents of which 21,000 were men and 30,000 women; the number of reported cases of stroke was 1,000 in men and 1,300 in women; age-adjusted prevalence of stroke (95 percent confidence interval) in men was 4.69 percent (4.33 percent to 5.07 percent) and in women 4.23 percent (3.94 percent to 4.53 percent); confidence intervals overlapped; and the p-value was 0.048. In contrast, the prevalence of two or more stroke risk factors was considered higher in men than in women in the NW region when the total sample size was 26,000 respondents of which 11,000 were men and 15,000 were women; the number of cases of two or more risk factors was 2,300 in men and 2,600 in women; age-adjusted prevalence of two or more risk factors (95-percent confidence interval) was 20.39 percent (19.51 percent to 21.31 percent) in men and 15.66 percent (14.99 percent to 16.35 percent) in women; confidence intervals were clearly separated; and the p-value was <0.001.[36]

Appendix B:
Glossary

The following terms are mentioned in the body of the report. Additional information can be found at the links provided. All links were active as of July 2008.

Antithrombotic therapy: Any type of therapy used to break up a clot (also known as a thrombus).

Atrial fibrillation: A fluttering or more quickly beating heart. Often, a risk factor for having a stroke.

Bias: Systematic error(s) in sampling or measuring that lead to a difference between the measurement and the truth. Examples of bias include a thermometer that always reads three degrees too high or a survey that under samples one group of people over another.

Body Mass Index (BMI): A method for measuring when a person is in a healthy weight zone for their height. Using a basic formula, BMI is calculated by: [Weight in pounds ÷ Height in inches ÷ Height in inches] x 703. More information can be found at: http://www.cdc.gov/nccdphp/dnpa/bmi/

Cardiovascular disease: Type of disease involving anything related to the heart or blood vessels. Heart disease is the number one cause of death in the United States. Many of the associated risk factors can be changed. More information can be found at: http://www.cdc.gov/heartdisease/

Confidence interval: A range of values around a percentage or rate within which we are reasonably confident that the true population percentage or rate lies. It is a measure of the variability of the data. The confidence intervals reported in this document are 95-percent confidence intervals, meaning that in 95 out of 100 instances the confidence interval should include the true population value.

Deep Vein Thrombosis (DVT): A blood clot (thrombus) in a deep vein, often occurring in the leg or arm. Symptoms include pain, redness, and swelling. Veins can travel to the lung or other areas of the body and cause critical health problems. http://www.cdc.gov/ncbddd/hbd/clotting.htm

Diabetes Mellitus: A condition where there is too much glucose in the blood and the body can't use it for energy. Insulin is used to carry the glucose into the cells to be used for energy. Diabetes is when there is a problem with how the insulin is working. There are two types: Type 1 and Type 2. More information can be found at: http://www.cdc.gov/diabetes/

- **Type 1:** The pancreas cannot make insulin. Often occurs in early childhood.
- **Type 2:** The pancreas cannot make enough, or the body can't recognize the insulin that is released. Often occurring in adulthood.

Dysphasia: Difficulty swallowing

Healthy People 2010: A national set of standards chosen as health goals for the nation. They were chosen after a long process of research and discussion among health professionals. The Healthy People 2020 goals are being developed. More information can be found at: http://www.healthypeople.gov/default.htm

High blood pressure (Hypertension): Often known as the "silent killer," most people don't realize they have high blood pressure. Awareness and prevention is key to maintaining healthy numbers. The normal range is: 120/80 mmHg for an adult. More information can be found at: http://www.cdc.gov/bloodpressure/

High cholesterol (Hypercholesteremia): High cholesterol is a risk factor for heart disease, stroke, and other conditions. Cholesterol is necessary for the body to function well, but too much cholesterol in the blood from fatty foods and other behaviors, deposits the excess fat into the artery walls. The arteries can harden and narrow, causing health problems such as heart attacks. More information can be found at: http://www.cdc.gov/cholesterol/index.htm

Incidence: Frequency of the occurrence of a disease or factor in a population within a certain time period. For example, the number of incident cases of diabetes in the NW region in 2007 is the number of newly diagnosed cases of diabetes in the NW region during 2007.

Modifiable risk factors: Characteristics that increase the risk of disease, but can be minimized with personal behavior changes.

Prevalence: Percentage of people with a disease or factor in a population at a given time, (includes both newly diagnosed cases and pre-existing cases). For example, the prevalence of heart disease in the NW region in 2007 is the percentage of the population in the NW region with heart disease who were alive in 2007 and who were diagnosed prior to and during 2007.

P-value: A statistic generated from a test of the difference between two groups or of a trend across three or more groups. The p-value indicates the strength of the evidence against the null hypothesis that there is no difference between groups. The smaller the p-value, the stronger the evidence against the null hypothesis, in other words, the stronger the evidence of a difference between the groups being tested.

Physical inactivity: Lack of regular physical movement and exercise. The Centers for Disease Control recommends one hour a day, every day, if possible. More information can be found at: http://www.cdc.gov/nccdphp/dnpa/physical/

Rate: Number of deaths (death rate) or hospitalizations (hospitalization rate) in a population scaled to the size of that population per unit time. In this report, rates are presented per 100,000 population per year. An example of a rate is that of stroke deaths in the United States in adults aged 45 years and older which is 152 deaths per 100,000 population per year.

RUCA = Rural Urban Commuting Area. More information can be found at: http://www.doh.wa.gov/data/Guidelines/RuralUrban.htm

Stroke: Known as a "brain attack," a stroke occurs because of disruption of blood flow to the brain. Approximately 80 percent of strokes are ischemic and 20 percent are hemorrhagic. More information can be found at: http://www.cdc.gov/stroke/index.htm

- **Ischemic:** Caused by a blood clot in the brain, causing a blocking of the blood flow, which cuts off oxygen to the brain. If given within three hours of first noticing symptoms, tPA is a "clotting-busting" drug that can reduce or eliminate disability and even death.
- **Hemorrhagic:** Caused by a blood vessel bursting in the brain. Other treatments, such as surgery, are used to treat this type of stroke.

Tissue Plasminogen Activator (tPA): An anti-clotting drug that breaks up blood clots in the brain during an ischemic stroke attack. This medicine is given within three hours of symptom onset by IV. It can also be given in the arteries, with a wider timeframe, but also with more potential health risks. More information can be found at: http://www.americanheart.org/presenter.jhtml?identifier=4751

Transient Ischemic Attack (TIA): A TIA is sometimes called a "mini-stroke," with the same symptoms as a full stroke, but symptoms resolve within 24 hours. TIAs are strong predictors of having a full stroke. Since a person cannot know if their symptoms are related to a TIA or full stroke, they should call 911 immediately. More information can be found at: http://www.nlm.nih.gov/medlineplus/transientischemicattack.html

Appendix C:
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