

CHAPTER 2 ORAL HEALTH INDICATORS

2.1 FINDINGS

2.1.1 SELECTION OF INDICATORS

Healthy People 2010 identified seventeen objectives related to oral health. These objectives are sometimes referred to as oral health indicators, and include dental caries experience, untreated dental decay, tooth removal from disease-related causes, periodontal diseases, oral cancer, use of dental sealants, public water fluoridation, and use of the oral health care system, among others (DHHS. 2001). In this report, we include analysis of three such indicators in the Appalachian Region and nationally: fluoridation of water supplies, a preventive measure; dental visits, an access measure; and tooth loss, an outcome measure.

2.1.2 FLUORIDATION OF WATER SUPPLIES

HISTORICAL CONTEXT

Water fluoridation was introduced in the twentieth century as a means to prevent dental caries (Bailey, et al. 2008; Kohlway. 2008), and is still considered the most effective method of reducing and preventing the incidence of dental caries (Griffin, Jones and Tomar. 2001; Mouradian, Wehr and Crall. 2000). It is inexpensive and disregards socioeconomic, racial, ethnic or age differences (Allukian. 2008). Some fluoridation occurs naturally. Only areas with low natural fluoride are candidates for supplementation. In 2011, CDC set new standards for water fluoridation at 0.7 ppm (EPA. 2011).

Although professionals continue to debate the proper level of fluoridation to protect teeth without creating challenges to other bone structures, fluoridation remains one of the most cost effective means of maintaining community oral health.

Safe and effective measures exist to prevent the most common dental diseases--dental caries and periodontal diseases. Community water fluoridation is safe and effective in preventing dental caries in both children and adults. Water fluoridation benefits all residents served by community water supplies regardless of their social or economic status (NIDCR. 2000).

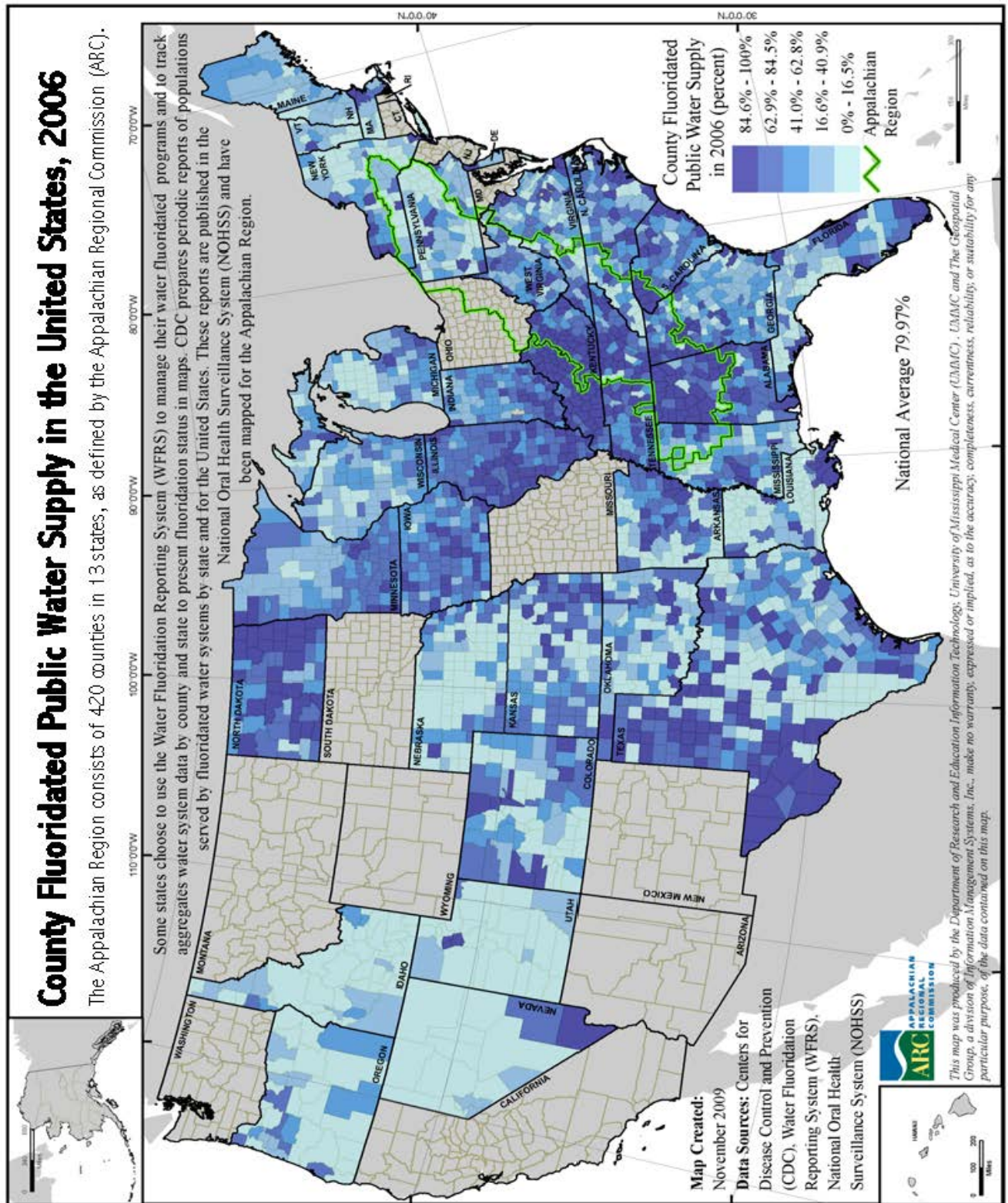
Some water supplies have natural fluoride; sea water, for example, has high fluoride levels. Areas reporting Community Water System (CWS) fluoridation monitor the levels. Others may monitor and not report, or not report and not monitor. In 2006, about 69 percent of the United States population that was served by CWS had access to fluoridated water (CDC. 2007). *Healthy People 2010*, the official public health plan for the United States, stipulated a goal of 75 percent fluoridation of CWS. Overall, public fluoridation efforts among states in Appalachia was very high, with ten of 13 states in the region ranking in the top 20 nationwide, and only one state, Mississippi, ranking in the bottom ten (CDC. 2009). New York was average with 73 percent; Pennsylvania, with 54.2 percent of the population on fluoridated CWS, was close to Mississippi, which reported 50.9 percent.

Population does not distribute evenly across a state’s geography. As illustrated in Figure 4, the Appalachian counties in New York and Pennsylvania have very few fluoridated CWS. By contrast, Kentucky, which contains half of Appalachia’s distressed counties, ranked highest in the region in 2006 with regard to proportion of persons served by fluoridated CWS (CDC. 2009). However, many people do not have access to or use publicly-supplied water. This “self-supplied” population includes up to 44 percent of residents in some states. This trend is particularly evident in rural areas.

TABLE 1 – APPALACHIAN STATES PERCENT OF POPULATION ON COMMUNITY WATER SUPPLIES WITH FLUORIDATED WATER

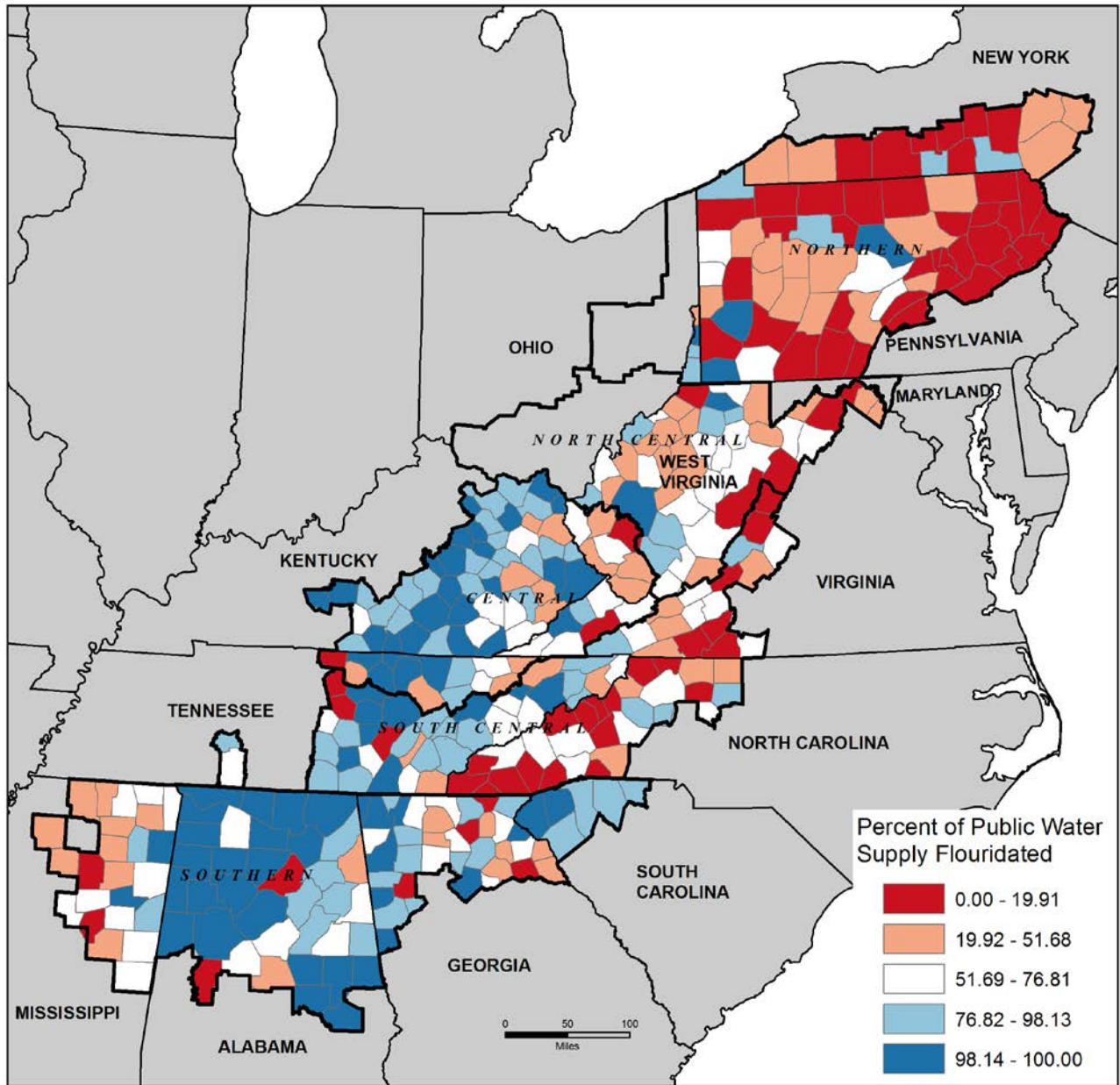
State	2006
Kentucky	99.8
Georgia	95.8
Virginia	95
South Carolina	94.6
Maryland	93.8
Tennessee	93.7
West Virginia	91.7
Ohio	89.3
North Carolina	87.6
Alabama	82.9
New York	72.9
Pennsylvania	54.2
Mississippi	50.9

FIGURE 3 - COUNTY FLUORIDATED PUBLIC WATER SUPPLY IN THE U.S., 2006



Note: Reporting is voluntary. In 2006, Maryland and Ohio did not report county data.

FIGURE 4 – COUNTY FLUORIDATED PUBLIC WATER SUPPLY IN APPALACHIA, 2006



Source: Water Fluoridation Reporting System (WFRS), Centers for Disease Control and Prevention, 2006 and National Oral Health Surveillance System, 2008.

Note: Maryland and Ohio did not report county data in 2006.

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APPALACHIA

States voluntarily report CWS fluoridation at the county level to the Centers for Disease Control and Prevention (CDC)³. Because many states do not report data at this level, national comparisons have limited utility. In Ohio, for example, reporting at the county level itself is voluntary. Figure 4 shows wide variation in reported fluoridation of public water supplies among Appalachian counties. Most counties have more than one water supply; hence, percent fluoridated is geographically uneven within a given county. Counties in the top CWS quintile have almost all (98 percent or more) public water supplies fluoridated, whereas counties in the bottom quintile have less than 20 percent of their public water supplies fluoridated. Almost one in five of reporting Appalachian counties was in the top quintile. However, the Southern, South-Central and Central regions show much higher levels of CWS fluoridation than the North-Central and Northern regions of Appalachia. For example, most Appalachian counties in Alabama provide fluoridated water to over 98 percent of residents served by CWS, compared to about half of Appalachian New York, where counties provide fluoridation to less than 20 percent of residents who use CWS. Note that Maryland and Ohio are missing in this sample. A better review of regional fluoride would include both externally supplied and naturally occurring sources. The United States Geological Survey has reported high levels of naturally occurring fluoride in New York and Ohio. However, these data are not annually verified and are subject to change from natural forces.

Table 2 shows persons using self-supplied water as a percent of the total population in Appalachian states. Data are statewide; rural regions are likely to have even higher proportions of people on self-supplied water, thus, less access to fluoridated public water.

TABLE 2 – USE OF SELF-SUPPLIED WATER IN APPALACHIAN STATES, 2005

State	Percent of total population served by self-supplied water
Alabama	11%
Georgia	18%
Kentucky	17%
Maryland	17%
Mississippi	19%
New York	10%
North Carolina	26%
Ohio	17%
Pennsylvania	20%
South Carolina	30%
Tennessee	9%
Virginia	22%
West Virginia	23%

Source: U.S. Geological Survey, 2005. <http://ga.water.usgs.gov/edu/wateruse/pdf/wudomestic-2005.pdf>

³ Forty percent of states were not reporting in the most recent data collected; thus, no national analysis on fluoridation was done.

The map in Figure 4 is drawn from CDC data, but the picture is incomplete because it excludes several water systems; self-supplied and school systems are not included. According to the 2005 United States Geological Survey, 10 to 30 percent of residents in 11 of the 13 Appalachian states use self-supplied water (United States Geological Survey, 2005), with disproportionately higher numbers in the rural counties.

Many states also have programs to add fluoride to school water supplies, independent of public water systems, and these are not counted in the CDC statistics. For example, Kentucky's Department of Public Health now provides fluoridated water to all rural schools (Kentucky DPH, 2011) as part of a larger oral health initiative. Kentucky also provides fluoride supplements and oral health education to all households that have small children and no access to a fluoridated water supply.

The research team was unable to find a good comparative source of naturally occurring groundwater fluoride. The United States Geological Survey appears to have a sampling and mapping system that is neither easily accessed, nor consistently updated. The Fluoride Action Network Pesticide Project also tracks naturally occurring fluorides in some state water supplies. However, its website notes that data may not be current⁴.

2.1.3 DENTAL VISITS

HISTORICAL CONTEXT

Defined as “having had a dental visit within the past 12 months,” regular dental visits are considered essential to maintaining good oral health and may reduce the incidence of oral health diseases by identifying and treating dental caries early (DHHS, 2000). Dental caries, more commonly known as tooth decay, are the number one childhood disease in the U.S. (Beltran-Aguilar, et al. 2005; Kagihara, Niederhauser, Stark, 2009). Although dental caries are considered preventable (Selwitz, Ismail, Pitts, 2007), the risk of developing dental caries is constant throughout a person's lifespan (Saunders, Meyerowitz, 2005) and the presence of dental caries affects quality of life at all ages (Selwitz, et al. 2007).

Researchers have associated development of dental caries with a variety of factors, including income, education, dental insurance coverage, oral hygiene behaviors, oral health knowledge, cultural beliefs and attitudes, age, race and ethnicity (Selwitz, et al. 2007). Lack of knowledge regarding the importance of maintaining oral health is a major contributing factor to oral health disparities (Selwitz, et al. 2007).

Dental sealants, or plastic coatings applied to the chewing surface of the tooth where decay is most common, have been highly effective in preventing dental caries and preserving good oral health (CDC, 2004). In fact, the 2000 Surgeon General's Report on Oral Health in America found that sealants reduced, by over 70 percent, the risk of developing dental caries; and sealants were cost-effective, especially when used on high-risk children and high-risk teeth. Several community and school-based programs promote use of sealants among dental providers and/or apply them on-site to vulnerable child populations. Reported decreases in caries and increased use of dental sealants occurred at a time when regular children's dental visits remained constant (Dye, et al. 2007).

With regard to demographics, the prevalence of dental caries in adults aged 20 to 64 is lowest among non-Hispanic whites, those with more than a high school education, and those at or above 200 percent of the federal poverty threshold (Dye, et al. 2007).

⁴ Fluoride Action Network Pesticide Project. Index to High Levels of Fluoride in U.S. Drinking Water On line <http://www.fluoridealert.org/pesticides/levels/index.html>

GEOGRAPHIC VARIATIONS IN DENTAL VISITS

For comparative profiles of dental visits, the CDC Behavioral Risk Factor Surveillance System (BRFSS) and National Health Interview Surveys (NHIS) are the only uniform sources of national data; both studies involve random telephone interview samples and are intended to capture national trends. Most BRFSS dental visit information can be aggregated only for large populations and adults. The amount of BRFSS data on the oral health of Appalachian children between 1999 and 2006 was insufficient for any meaningful mapping or analytical exercise. Similarly, these data sets are too sparse for use in same-year county comparisons; and multi-year comparisons of small area data suffer from variations in sampling frames and question structure.

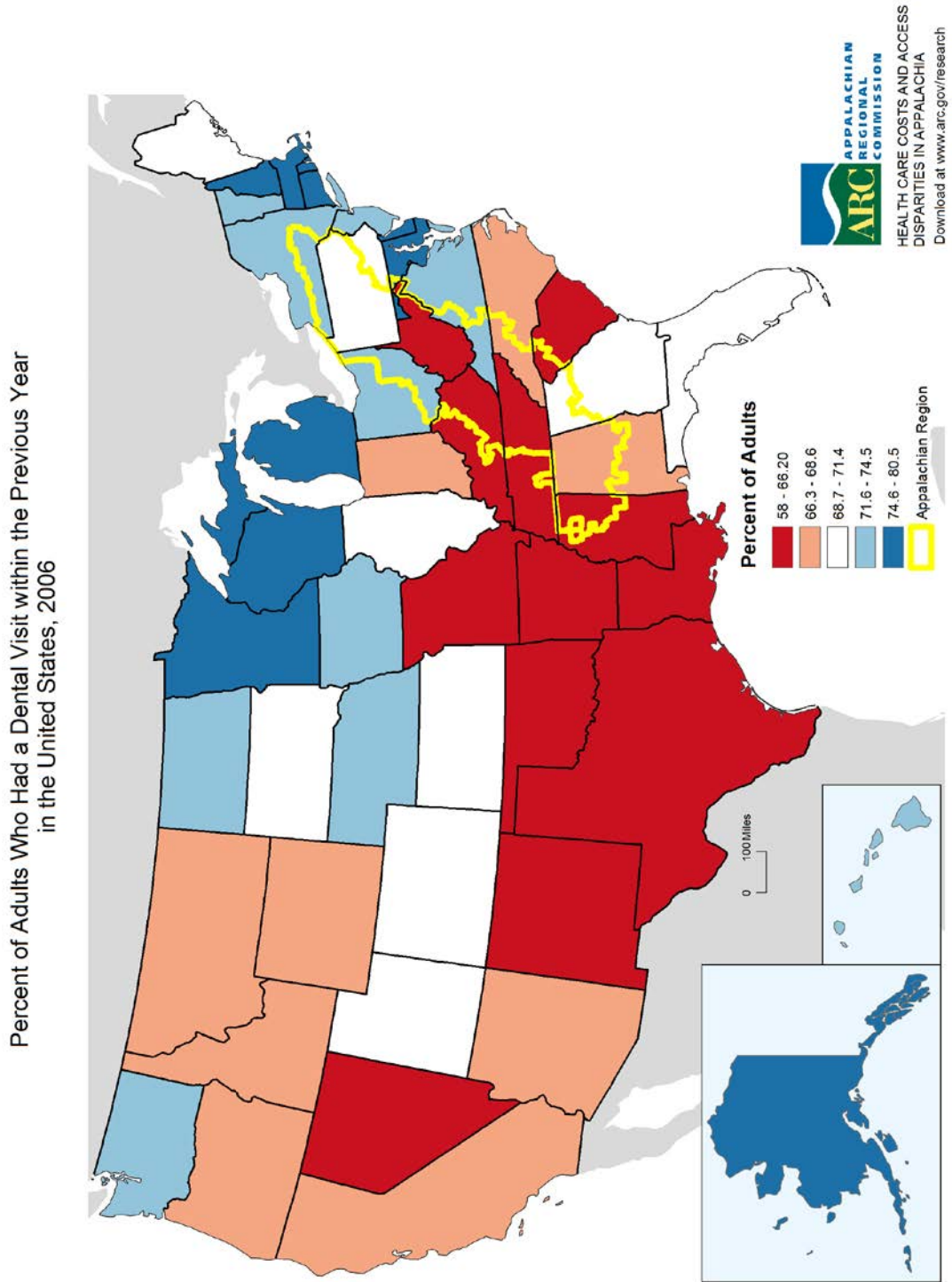
BRFSS sample frames are too limited to provide meaningful information about the oral health of Appalachian children.

BRFSS data can be used for state comparisons of adult oral health disparities and the contrasts are stark. Figure 5 shows, at the state level, the percentage of adults responding to BRFSS surveys who reported at least one regular dental visit in 2006. Reports of one visit for individual states ranged from 58 to 80.5 percent of surveyed adults.

The map is scaled in quintiles, with blue areas indicating a high percentage of adults who had a regular annual dental visit and red areas indicating a lower percentage. Nationally, most states in the lowest quintile are in the South and West, while states in the highest quintile are in the Northeast and upper Midwest. On par with the country as a whole, at least half of Appalachia is characterized by red areas, where less than 68 percent of the adult population received a regular dental visit. Five of the ten United States states in the lowest quintile are in Appalachia: Mississippi, Tennessee, South Carolina, Kentucky and West Virginia. Maryland is the only Appalachian state in the highest national quintile for this indicator.

Although this map illustrates unequal use of dental care among state populations, important sub-state variations in availability of dental care, repeated in other limited, small area studies, highlight even deeper disparities in the Appalachian Region. In Appendix C, researchers aggregated BRFSS data over multiple years in order to get enough data to separate Appalachian from non-Appalachian areas. Because the aggregations extend over eight and more years, the information is best interpreted only for trends.

FIGURE 5 – PERCENT OF ADULTS WHO HAD A DENTAL VISIT WITHIN THE PREVIOUS YEAR IN THE U.S., 2006



The NHIS annually samples visits by age group. By 2009, 59.6 percent of the population reported having a dental visit in the past year, with slightly higher percentages of children than adults reporting visits. These data, too, are only reported by state.

TABLE 3 – PERCENT OF PERSONS WHO REPORTED A DENTAL VISIT IN THE PAST YEAR, BY AGE GROUPS, UNITED STATES, SELECTED YEARS 1997–2009

Age	2 years and over			2-17 years			18-64 years			65 years and over ¹		
Year	1997	2008	2009	1997	2008	2009	1997	2008	2009	1997	2008	2009
Total	65.1	63.9	65.4	72.7	77.3	78.4	64.1	60.4	62	54.8	57.6	59.6

Source: CDC/NCHS, NHIS, sample child and sample adult questionnaires. Appendix D.

¹Based on the 1997 through 2009 NHIS, about 24% to 30% of persons 65 years and over were edentulous (having lost all their natural teeth). In 1997 through 2009, about 69% to 73% of older persons were edentate and 17% to 21% of older edentate persons had a dental visit in the past year.

A National Survey of Children’s Health prepared by the CDC in cooperation with the Health Resources and Services Administration (HRSA) looked at children’s preventive dental care in 2007. Data in Table 3 show quintiles by Appalachian state. The average for all states was 79.4 percent. Appalachian states ranked at or above the national average on this metric.

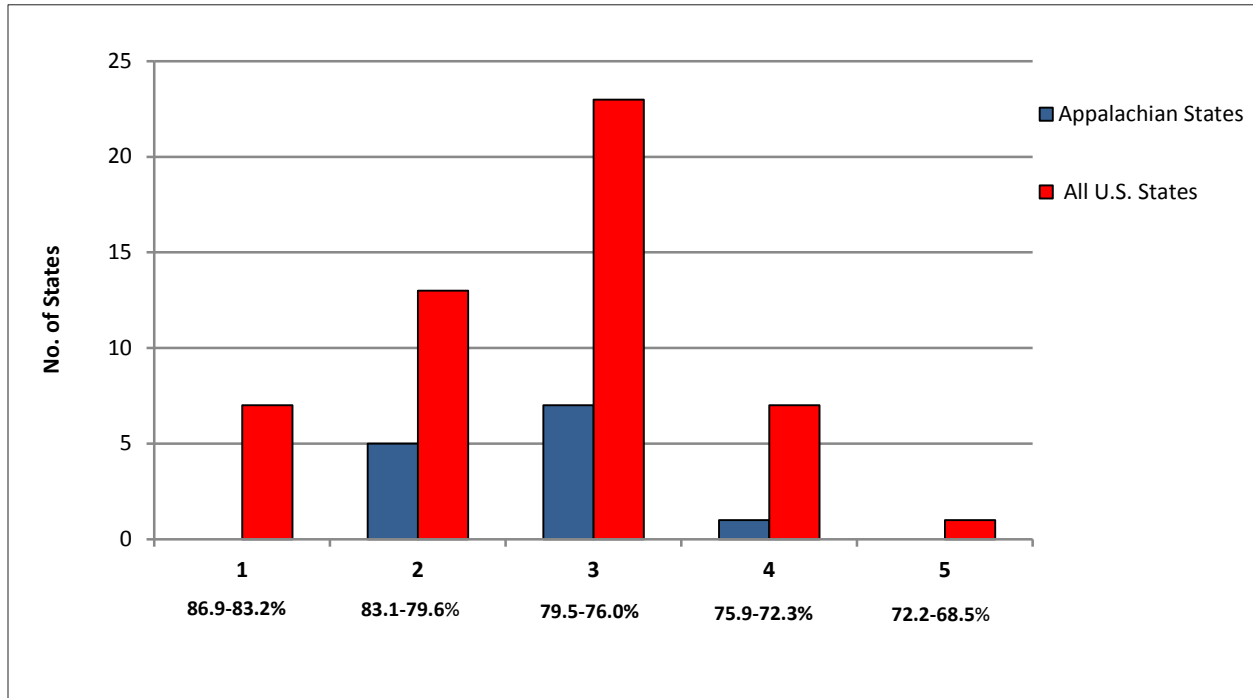
TABLE 4 – PERCENT OF CHILDREN WITH PREVENTIVE DENTAL CARE IN THE LAST 12 MONTHS IN APPALACHIAN STATES, 2007

Appalachian State	Percent of Children Receiving Preventive Dental Care	Quintile
Pennsylvania	82.7%	2
South Carolina	82.0%	2
New York	80.8%	2
Georgia	80.3%	2
West Virginia	80.3%	2
Maryland	79.1%	2
Virginia	79.0%	3
Tennessee	78.8%	3
Ohio	78.7%	3
Alabama	78.4%	3
Kentucky	78.4%	3
North Carolina	78.3%	3
Mississippi	75.5%	4
U. S. Average	79.4%	

Source: National Survey of Children’s Health 2007 prepared by HRSA and CDC

Children’s use of preventive dental services in Appalachian states was close to the national average. Figure 6 shows no Appalachian state in the highest or the lowest quintiles on the measure of children using preventive dental services in the last 12 months in 2007.

FIGURE 6 – PERCENT OF CHILDREN USING PREVENTIVE DENTAL CARE, 2007



Source: National Survey of Children’s Health 2007 prepared by HRSA and CDC
<http://childhealthdata.org/learn/NSCH>

Year after year, regardless of age, the percentage of NHIS respondents reporting of recent dental visits is smaller for persons inside metropolitan statistical areas (MSA’s) than outside MSA’s.

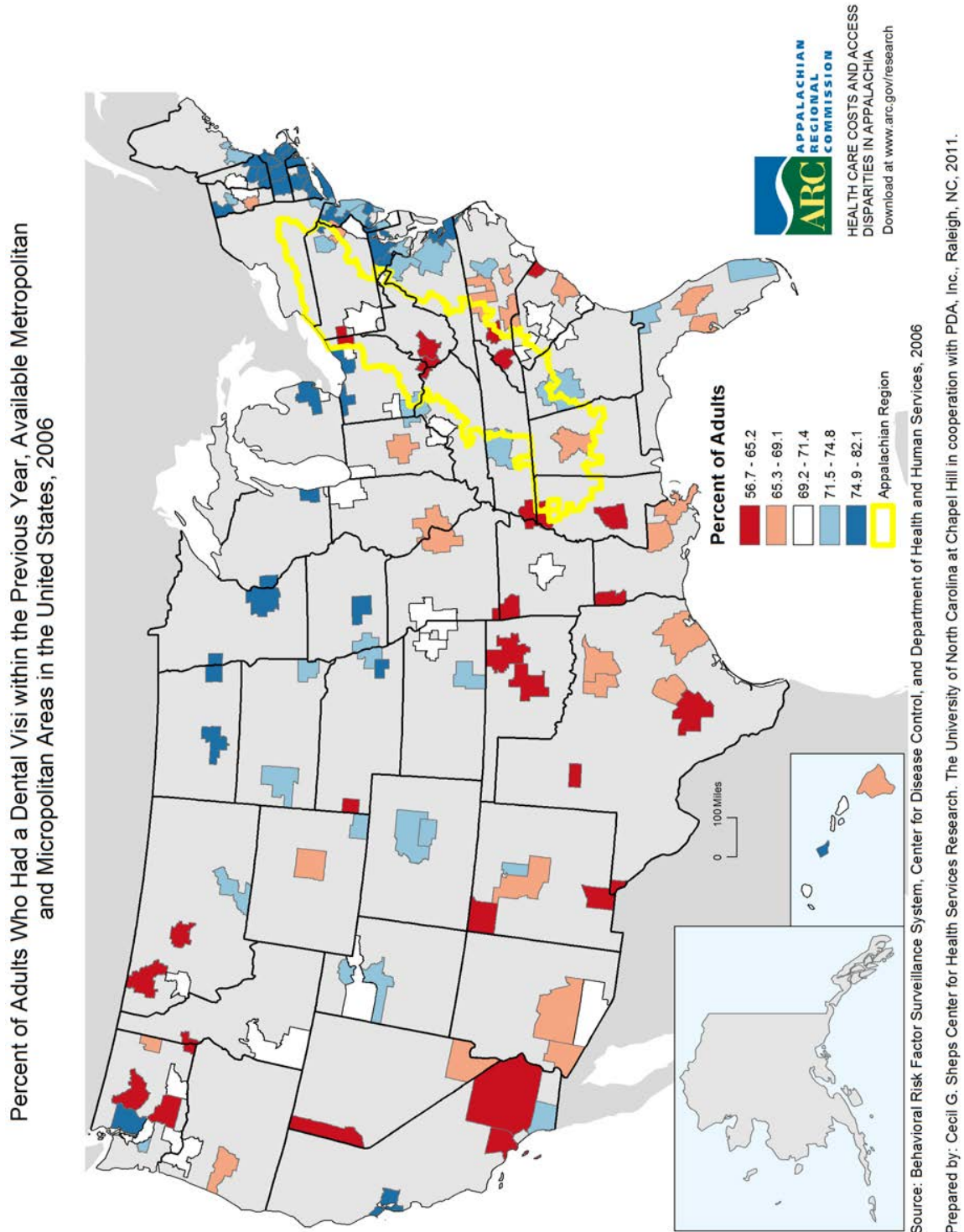
TABLE 5 – PERCENT OF PERSONS WHO REPORTED A DENTAL VISIT IN THE PAST YEAR, BY AGE GROUP, METRO AND NON-METRO AREAS IN THE UNITED STATES, 1997-2009

Age	2 years and over			2-17 years			18-64 years			65 years and over ¹		
	1997	2008	2009	1997	2008	2009	1997	2008	2009	1997	2008	2009
Within MSA	66.7	65.1	66.5	73.6	77.7	79.0	65.7	61.5	63.1	57.6	60.3	61.8
Outside MSA	59.1	57.9	59.5	69.3	75.1	75.5	58.0	54.5	55.9	46.1	48.3	51.3

Source: CDC/NCHS, NHIS, <http://www.cdc.gov/nchs/data/hus/2010/093.pdf> See Appendix D.

Figure 7 maps the very limited BRFSS geographic data sample. It shows the geographic limitation of the metropolitan/ micropolitan sample frame. However it illustrates large national geographic variations in adult dental visits even in urban areas. The mapped data are for 2006 for reporting metropolitan (large urban) and micropolitan (small urban) areas throughout the United States. In the surveyed areas, visit patterns were similar to state visit patterns, with about 56 to 82 percent of adults reporting regular dental visits. Southern and Western urban areas favor the lower two quintiles and the Midwestern and Northeastern urban areas fall in the higher two quintiles.

FIGURE 7 –DENTAL VISITS WITHIN THE PREVIOUS YEAR, METROPOLITAN AND MICROPOLITAN AREAS IN THE U.S., 2006



*This map offers a snapshot of the limited data available on dental visits in reporting metropolitan and micropolitan areas, or any area with at least 10,000 people in its “urban core” (U.S. Census Bureau 2011). There are no data for many of the metropolitan areas within Appalachia. Please see Appendix A.

APPALACHIAN STATES

The University of Mississippi Medical Center conducted a statistical analysis of multiple years of BRFSS survey results, which are detailed in Appendix C. The analysis shows that on average, adult residents of Appalachian and non-Appalachian areas reported similar patterns of regular dental care. Table 6 shows the percent of Appalachian adults who reported regular dental visits from 1997 to 2007. However, study results indicate that from state to state, adults 18 or older who reported a regular dental visit varied as much as 45 percent. In metropolitan Appalachian Mississippi, only 39.2 percent of adults reported visits within the year, compared to metropolitan Virginia *outside* of Appalachia where 74.2 percent reported visits (BRFSS. 1997-2007). Please see Figure 7 for state results.

TABLE 6 - ADULT ANNUAL DENTAL VISITS 1997-2007, BY LOCATION
ADULTS WHO HAD A DENTAL VISIT WITHIN THE PAST 12 MONTHS

Location	Appalachian Region	Non-Appalachian Region
Metropolitan	65%	68%
Non-metropolitan	65%	66%

Source: Observed unadjusted values, from survey responses 1997-2007; BRFSS; CDC.

As noted earlier, the BRFSS data samples do not permit a systematic review at the sub-state level. The map in Figure 7 shows the BRFSS sampling areas for Metropolitan and Micropolitan areas. All other data are sampled in “rest of state categories.” The University of Mississippi research team used algorithms to assign values to Appalachian portions of metropolitan and non-metropolitan areas.

Table 23 in Appendix C compares individual Appalachian states on the oral health indicator ‘Dental Visit in Last Year’, and shows the range of prevalence at a high of 74.2 percent having visited the dentist within the past year for metropolitan Virginia, *outside* Appalachia, to a low of 39.2 percent having visited a dentist in metropolitan Mississippi *inside* Appalachia. That lowest prevalence (rank 49) in Appalachian Mississippi is substantially lower than 48th ranked non-Appalachia, non-metropolitan Mississippi (at 54 percent). For the most part, the metropolitan regions have a higher prevalence of annual dental visits than the non-metropolitan areas. In other words, there is little difference in the prevalence of visits to the dentist in the past year between Appalachia and non-Appalachia metropolitan areas. Thus, the maps in Figures 7 and 9, though limited, do provide insight to oral health status in the region.

2.1.4 TOOTH REMOVAL

FIGURE 8 – SENIORS AGE 65 OR OLDER WITH ALL TEETH REMOVED IN THE U.S., 2006

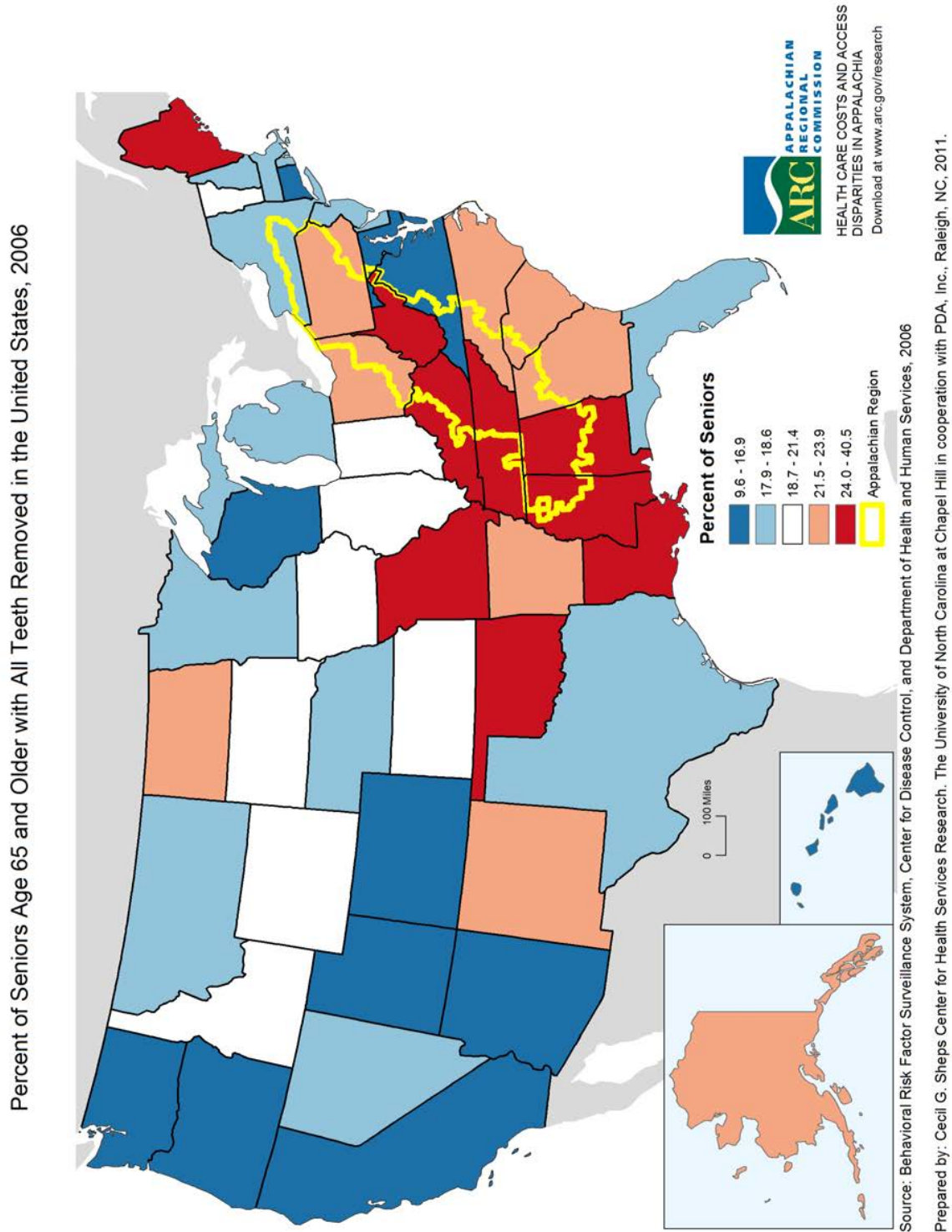
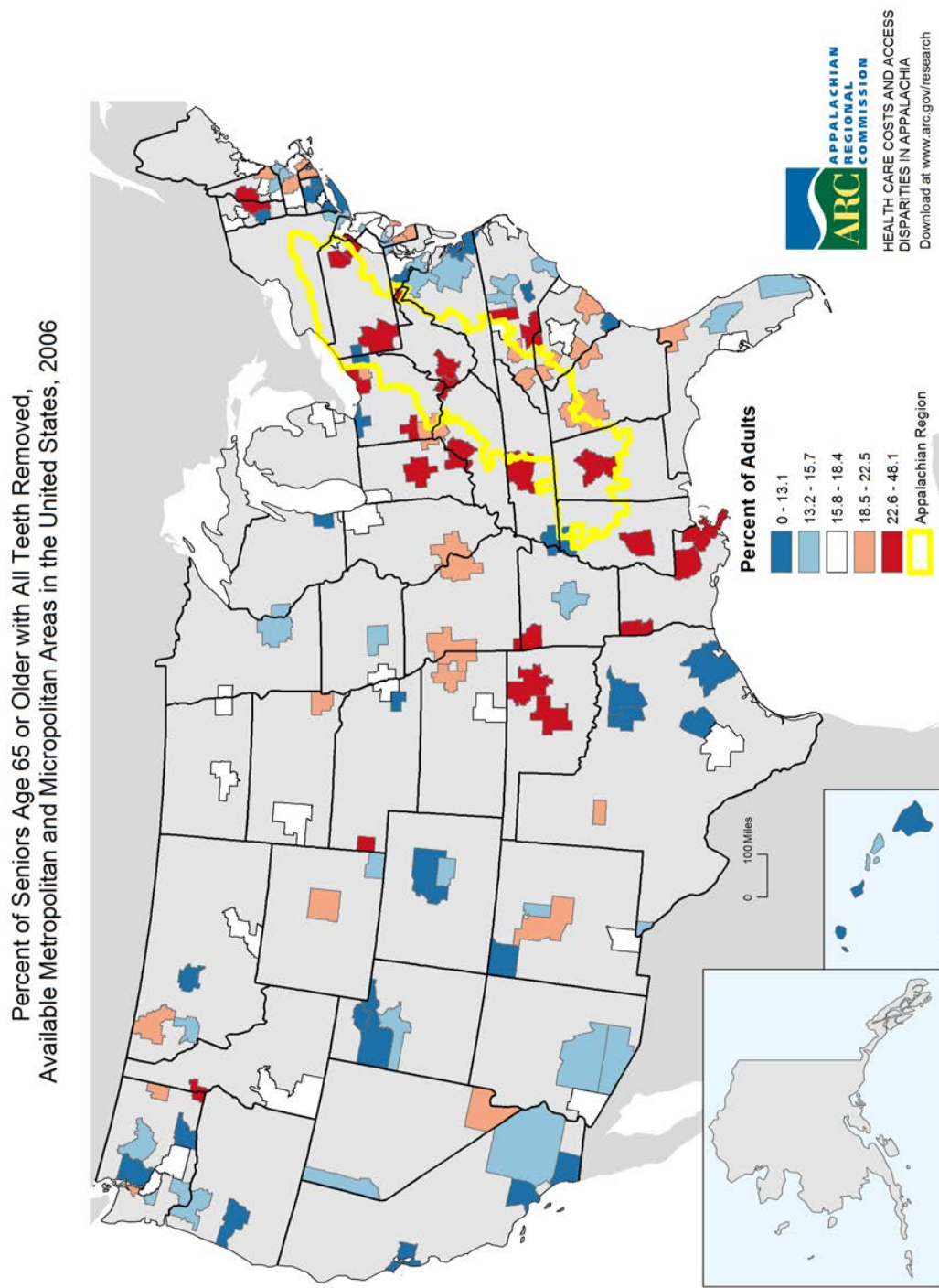


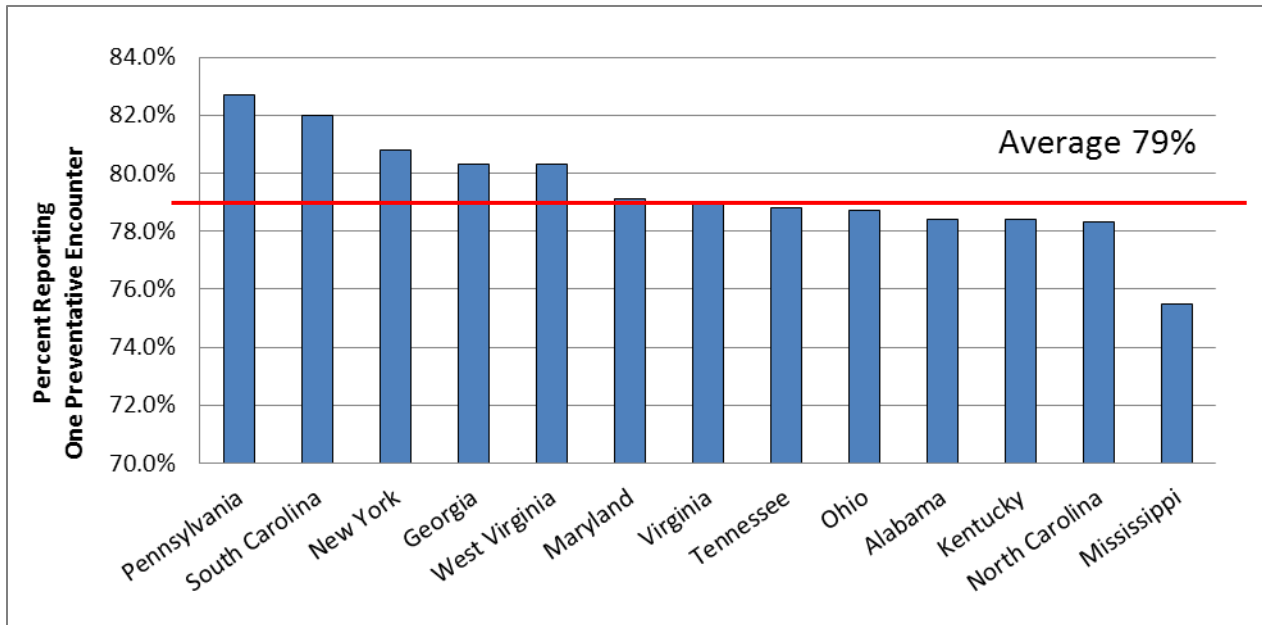
FIGURE 9 – SENIORS AGE 65 OR OLDER WITH ALL TEETH REMOVED, METROPOLITAN AND MICROPOLITAN AREAS IN THE U.S., 2006



*This map offers a snapshot of the limited data available on tooth removal among seniors in the reporting metropolitan and micropolitan areas, or any area with at least 10,000 people in its “urban core” (U.S. Census Bureau, 2011). There are no data for many of the metropolitan areas within Appalachia. Please see Appendix A.

The results of a 2007 survey of children’s preventive dental care in Appalachian states are similar to reports for the entire United States. On average, 79 percent of children in Appalachian states reported having preventive dental care in the past year, but Appalachian states represented both the highest and the lowest in the United States. However, even in the lowest state, Mississippi, 75.5 percent of children reported receiving preventive dental care. In Pennsylvania, 82.7 percent reported receiving preventive dental care (CDC. 2007).

FIGURE 10 – STATUS OF CHILDREN’S PREVENTIVE DENTAL CARE IN APPALACHIA, 2007



Source: National Survey of Children’s Health 2007, Department of Health and Human Services, Maternal and Child Health Bureau of the HRSA.

These reports merely scratch the surface; none tested completeness of care or distinguished between screening and treatment. The National Survey of Children’s Health (2007) also noted that family income and presence of dental insurance accounted for major differences in use of services. “While 82.4 percent of children with private health insurance and 76.2 percent of those with public insurance received preventive dental care, only 58.5 percent of uninsured children did so.”

HISTORICAL CONTEXT

Though Tu and Gilthorpe (2005) carefully observed the lack of definitive research to determine whether the relationships between tooth loss and good health is truly causative or an outcome of other bad health practices, primarily smoking, researchers agree that a relationship does exist.

Sanders, Spencer and Slade (2006) found that adults residing in disadvantaged areas had more teeth removed, on average, than adults residing in more affluent areas. Over time, tooth retention has generally improved among adults (Dye, et al. 2007). While this generally indicates improved oral health, having more teeth also puts a person at an increased risk of dental caries (Selwitz, et al. 2007). Tooth removal in adults is also significantly associated with certain behaviors, such as smoking (Tomar and Asma, 2000; Yanagisawa, et al., 2009). However, details on lifestyle factors are not examined in this report.

STATE AND METRO AND MICROPOLITAN AREAS

Figure 8 shows state level estimates of the percent of older adults that reported having all of their teeth removed as a result of preventable causes. This is generally considered an indicator of a life history of poor oral health and/or inadequate access to high quality oral health care. States ranged from a low of 9.6 percent (dark blue states) to a high of 40.5 percent (dark red states). Nationally, most states in the lowest quintile were in the Southeast and Lower Midwest, while states in the highest quintile were on the Pacific Coast and Southwest. In general, Appalachian states reflect this pattern: seniors in Southern Appalachian states are more likely to report being edentulous (toothless) than those in Northern Appalachian states. Five of the ten United States states in the lowest quintile are in Appalachia (Alabama, Mississippi, Tennessee, Kentucky and West Virginia), and five more Appalachian states fall within the next lowest quintile (Georgia, South Carolina, North Carolina, Ohio and Pennsylvania). Only two Appalachian states, Virginia and Maryland, both states with relatively few Appalachian counties, are in the highest national quintile that reported the fewest teeth removed.

Similarly, Figure 9 shows the percentage of seniors reporting all teeth removed in the same reporting metropolitan and micropolitan areas described earlier (BRFSS, 2006). The scale ranges from zero to 48.1 percent of seniors. Resembling the state profiles in Figure 8, the Southeast and lower Midwest reporting urban areas favor the lower two quintiles, while the Western part of the country favors the higher two quintiles. Again, Appalachian urban areas appear to be far behind the rest of the country on this metric. Nationally, 27 states contain reporting urban areas that fall within the lower three quintiles (15.8 to 48.1 percent of adults had all teeth removed). In Appalachia, nine of 13 states contain urban areas that fall in this lower range. Only very small parts of Appalachian Pennsylvania, Ohio and Alabama report fewer than 15.8 percent of seniors with all teeth removed among reporting urban areas.

These samples are too incomplete to provide conclusive assessments. At best, they suggest areas for more detailed investigation.

APPALACHIA

The wide variation in patterns of oral health indicators among Appalachian states and between metropolitan and non-metropolitan areas is less noticeable when the Appalachian Region is considered as a whole. Table 7 shows degrees of tooth removal reported by residents of Appalachian states over an eight-year period (from 1999-2006). Because BRFSS surveys contained too few samples from the Appalachian Region to provide significant information in a single year, raw survey data were extracted and summarized over the eight year span.

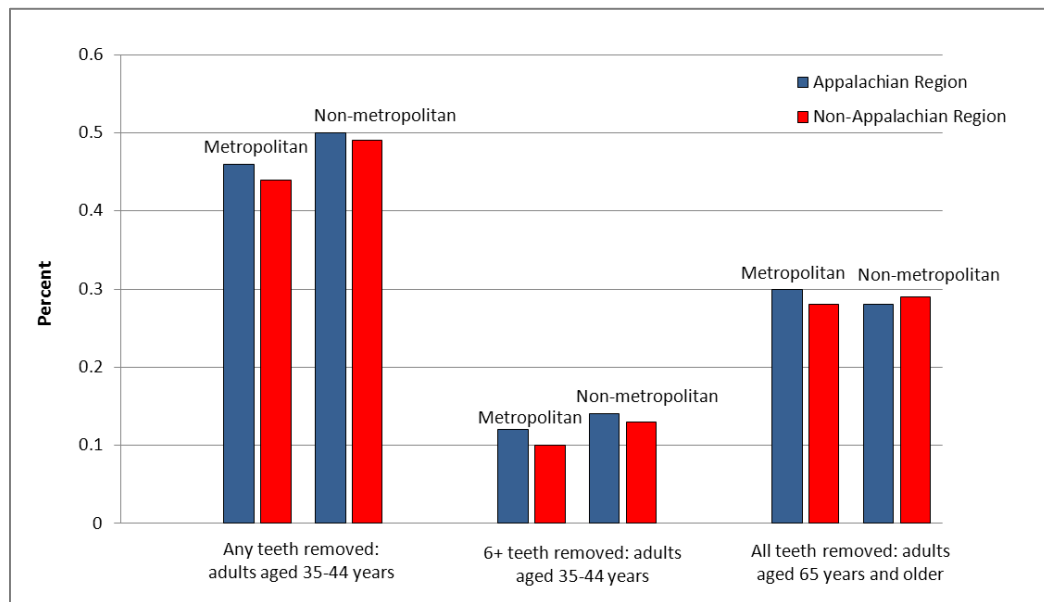
Appendix C contains the statistics by state for each of the years. At the aggregate level, geographic patterns are similar inside and outside Appalachia. At the small area level, adults with any teeth removed varied from only 31.1 percent in metropolitan Virginia, *outside* of Appalachia, to 65.2 percent in Appalachian areas of non-metropolitan Kentucky. Similarly, adults in this age range, with six or more teeth removed, varied in Appalachian regions from only 4.5 percent in metropolitan Georgia to 25 percent in non-metropolitan Kentucky. Geographically, seniors, adults aged 65 or older, reporting all teeth removed varied almost 40 percent. Reporting metropolitan areas differed substantially. Only 14.4 percent of seniors in metropolitan Virginia, *outside* of Appalachia reported all teeth removed; this compares to 54.3 percent in non-metropolitan areas of Appalachian Kentucky. Because of the time lapse in the data, results should be considered indicators rather than exact measures. Any teeth removed, refers to removal only as a result of disease or decay.

TABLE 7 - ORAL HEALTH STATUS IN APPALACHIAN STATES 1999 -2006

Location	Appalachian Region	Non-Appalachian Region
Any teeth removed: adults aged 35-44 years		
Metropolitan	46%	44%
Non-metropolitan	50%	49%
6+ teeth removed: adults aged 35-44 years		
Metropolitan	12%	10%
Non-metropolitan	14%	13%
All teeth removed: adults aged 65 or older		
Metropolitan	30%	28%
Non-metropolitan	28%	29%

Source: BRFSS and CDC, 1999-2006. Data assembled by University of Mississippi Medical Center, 2010.

FIGURE 11 – REPORTED TOOTH LOSS BY AGE AND METRO VERSUS NON-METRO GEOGRAPHY 1999-2006



Source: BRFSS Raw Survey Data 1999-2006. Statistics. See Appendix C.

For all three oral health indicators, the variable that explains any apparent small differences between Appalachian and non-Appalachian counties or between metropolitan and non-metropolitan counties is the level of poverty in the county in which these individuals lived. People, who live in counties where a larger percentage of the population is poor, tend to be less likely to report a dentist visit and report poorer oral health status as measured by tooth removal. When data were statistically controlled for the level of poverty of the community, any distinctive Appalachian or non-metropolitan effect was less apparent. The statistical analysis supporting this conclusion is developed in Appendix C.

2.2 METHODOLOGY

2.2.1 NOTE ON DATA

There is a dearth of meaningful, up-to-date data available for the study of Appalachia’s oral health status. The majority of available data are from survey results that are five to 13 years old. Small sample sizes in those databases have required that multi-year (and often multi-state) data be aggregated in order to produce meaningful analysis. Even then, for the oral health indicators studied, there was insufficient data to draw any meaningful conclusions about the current oral health status of children. The data used in this study do not include measures of lifestyle behaviors, such as oral hygiene, nutrition and tobacco use, which also influence oral health status.

2.2.2 FLUORIDATION OF WATER SUPPLIES

DATA SOURCES

About 60 percent of states voluntarily report the counties that fluoridate public water supplies to the CDC, and these are made public. The most recent available data on this indicator is for 2006. With 40 percent of states not reporting, national analysis was unreasonable. Fortunately, all but two Appalachian states, Maryland and Ohio, reported on this indicator in 2006. Thus, a map of Appalachian counties presents a reasonable comparison. Please see Figure 4.

The water fluoridation measure used in this study is the percent of the county population receiving fluoridated water from public water supplies. Data for all United States counties were obtained from the CDC (CDC, 2009). A spreadsheet of these data was created for analytical and mapping purposes. Not only are data voluntary and may not be reported by all states, they are continuously sampled. Data are updated every 24 hours. Spreadsheet data mapped in Figures 3 and 4 are scaled differently. In Figure 3, the scale is distributed in a normal bell curve. Figure 4 data are distributed evenly in five percentile groups. Percentages listed in the legend are those associated with the percentile group.

The National Survey of Children's Health (2007) was sponsored by DHHS, Maternal and Child Health Bureau of the HRSA and conducted under contract to University of Chicago National Organization for Research at the University of Chicago. These were telephone interviews conducted from April 2007 through June 2008 producing a sample of 91,642 completed interviews for children ages 0 through 17.

DATA ANALYSIS

A spreadsheet of data from all counties in the 11 reporting Appalachian states was created for analytical and mapping purposes, and can be found in Appendix C. Figure 4 was produced to depict fluoridation efforts in Appalachia; blue areas represent those counties in the upper two quintiles, and with the most fluoridation; red areas represent those counties in the lower two quintiles, and with the least fluoridation.

MAPPING

Water fluoridation at the national level, Figure 3, was prepared by researchers from the University of Mississippi Medical Center. Figure 4 was produced from raw data assembled by the University of Mississippi researchers, and regrouped to display five equal categories on a color scheme that represents low performance, in red, to high performance, in blue; white represents average percentages. Both maps represent percentage of community water supplies that were fluoridated.

2.2.3 DENTAL VISITS AND TOOTH REMOVAL

DATA SOURCES

Data on regular dental visits and tooth removal are publicly available from a CDC-sponsored, state-administered annual survey, BRFSS. The BRFSS is an extensive, continuous telephone health survey used for monitoring health conditions and health-risk behaviors across the entire United States, the District of Columbia, Puerto Rico, U.S. Virgin Islands and Guam. The survey is designed to estimate state-level information on health behaviors and disease prevalence through the use of a probability sample accomplished through a random selection of telephone numbers. Most data are available only at the state level and are current only to 2006.

For the state and metro/micropolitan analyses, only 2006 (single-year) BRFSS data were used. For the Appalachian area analysis, no single year of BRFSS data set is sufficient for generalized analysis. Thus, the analyses here involves aggregate BRFSS data over eight to eleven years, 1999 through 2006 and 1997 through 2007, to estimate oral health status and service use in smaller sub-state areas within the Appalachian Region.

The complete BRFSS dataset for 1999 through 2006 contains 2,085,241 individual records based on yearly probability samples aimed at estimating prevalence of health indicators and health behaviors for all 50 states. Of these, only 543,204 respondents, to three different questions, came from the Appalachian Region. Four oral health indicators were obtained from the BRFSS datasets: adults who reported a dental visit within the past 12 months, those aged 35 to 44 reporting any tooth removal, those aged 35 to 44 reporting six or more teeth removed, and those aged 65 or older reporting all teeth missing. Table 8, which lists the small and varying annual sample sizes for the indicators, demonstrates why researchers aggregated so many years of data. However, data aggregated over so many years should be considered carefully and with limitations.

TABLE 8 - SAMPLE SIZES FOR ORAL HEALTH INDICATORS: NUMBER OF APPALACHIAN RESPONDENTS BY YEAR (N=543,204)

Year	Adults who had a dental visit within the past 12 months	Respondents for six tooth removal indicators, aged 35 to 44	Seniors aged 65 or older with all teeth removed
1999	40,898	8,919	7,864
2000	9,766	2,268	1,578
2001	15,599	3,306	2,901
2002	67,931	13,747	14,273
2003	23,965	4,840	4,660
2004	79,227	14,771	18,082
2005	9,511	1,638	2,293
2006	95,441	16,614	25,230
Total	342,338	65,103	76,881
Number surveyed for this question	342,338	65,614	76,881

Source: CDC/BRFSS, 1999-2006. See Appendix C. Note annual totals do not match reported surveys for the Ages 35-44 group.

Using this dataset to draw generalizations about the Appalachian Region as a whole has important limitations:

- BRFSS responses are not reported each year in every state. Thus, if only one or two states reported much of the data on a single indicator, estimates at the regional level might disproportionately reflect the situation in the reporting states and not accurately reflect the overall region.
- Not every question is asked in every state, so some indicators may be heavily skewed toward certain states and less representative of the entire region.
- Numbers of responses differ substantially from year to year; for example, nearly ten times as many people responded about dental visits in 2006 (95,411 people) as in 2005 (9,511 people).
- The total sample sizes of aggregated data are still small, relative to the 24.8 million people in the region.
- Some data appear to be missing for the 35 to 44 age group.
- All data were collected by random telephone survey. Samplers in most states tried to incorporate cell phones.

The University of Mississippi Medical Center analysis did summarize information at the state level, and is included in Appendix C. Though the data indicate wide variation in oral health status measures among the Appalachian states, the limitations urge the reader to avoid drawing conclusions about individual states. The more important message is in the absence of a reliable baseline estimate of annual change in Appalachian oral health status.

The CDC, National Center for Health Statistics (NCHS) maintain several databases from interview surveys. However, with regard to dental care, none is robust enough to provide information at the Appalachian Region-level over time.

DATA ANALYSIS

The BRFSS survey was designed to estimate health behaviors at the state-level, and the yearly estimates are reasonably good approximations of the state-level population prevalence. Estimates for areas smaller than the state level require attention to sample size issues. The data may be sparse when isolated to small local areas, particularly when further separated for three age-specific oral health/behavior indicators. The CDC suggests that estimates be based on at least 50 individual observations for a specific small area. As a first attempt at analysis, University of Mississippi research team estimated the prevalence proportions for each of the three indicators at the county level. In the Appalachian states, there are a total of 1,070 counties. Of these, only 531 counties had at least one respondent to at least one of the oral health/behavior indicator questions. The strict requirement of at least 50 observations retains estimates for a reduced number of counties as listed in the following table:

TABLE 9 - ASSESSMENT OF COUNTIES IN APPALACHIAN STATES REPRESENTED IN BRFSS DATA

Indicator	Number of counties with 1+ observations	Number of counties with 50+ observations
Visit Within 1 Year	504	496
Any/Major Removal (35-44)	503	260
Major Removal (65+)	503	311

Source: BRFSS Surveys aggregated 199-2006, See Appendix C.

Therefore, difficulties with sample size requirements for the BRFSS county-level estimates warranted other approaches for identifying differences between Appalachian and non-Appalachian Regions within the Appalachian states. Initially, the University of Mississippi research team considered using the county-level prevalence estimates of the oral health/behavior indicators from the aggregated 1999-2006 BRFSS data.

MSA and non-MSA conclusions were developed by aggregating BRFSS data from Appalachian states to metropolitan versus non-metropolitan and Appalachian versus non-Appalachian Regions within each state. Area estimates were made for 39 separate regions, with varying levels of precision (see Appendix A for map of regions used, and detailed statistical analyses). Note that the number of children in the survey was still too small to use for separate analyses.

The major limitations of this method include: better estimates in metropolitan areas than in rural areas; better estimates for adults than for children; and a lack of adequate data points for meaningful county-level estimates. Moreover, the large deficiency of county-level and rural data leave a largely incomplete picture of the current state of oral health in Appalachia. Increased data collection, or over-sampling, in the Appalachian Region is highly advised as a part of future policy and best practice recommendations.

As noted in Appendix C, the University of Mississippi research team submitted a proposal to the NCHS Research Data Center requesting oral health indicator data from the NHANES survey aggregated to the county-level for the Appalachian states. After several revisions and conversations with NCHS staff, they received the following from an NCHS reviewer:

“As I understand the analyses of interest, the researchers are interested in presenting oral health measures stratified by individual counties. **The proposed analysis cannot be done without presenting disclosure risk. We do not allow presentation of data at the county level.** Secondly, there are practical issues that raise questions about the feasibility of the analysis as planned. NHANES goes to 30 sites (which are individual counties) per year. Respondents are not selected to be representative of the population of individual counties.”

MAPPING

Reported Dental Visits, and Teeth Removed, were mapped using data prepared by researchers from the University of Mississippi Medical Center (Krause. 2010) or directly from data extracted from HRSA Area Resource Files by the Cecil G. Sheps Center for Health Service Research, University of North Carolina at Chapel Hill. Unless otherwise noted, the UNC Sheps staff opened the Mississippi map compositions, found locations of source data and made new maps in a consistent style, using categories determined by national quintiles. Data sources and attribution were inferred from information in a first draft of this report (Krause. 2010) and data archives labeled as being source data for maps.

2.3 SUMMARY AND DISCUSSION

2.3.1 ORAL HEALTH INDICATORS AND APPALACHIA

Spatial analyses of water fluoridation, dental visits, and tooth extractions generally reflect poorer oral health in parts of the Appalachian Region than in the nation as a whole. Nationally, metropolitan areas reported better oral health than non-metropolitan areas, and this trend largely holds true for Appalachia. Southern and Central Appalachian states tend to have poorer overall measures of oral health than Northern Appalachian states. Maryland and Virginia reported the best oral health status, while Southern Appalachian States reported the worst.

While there is substantial variability in the extent of water fluoridation and access to public water supply within Appalachia, most areas in Southern and Central Appalachia fluoridate 75 percent or more of the public water supply. Northern Appalachia is less active with water fluoridation efforts, with much of the area fluoridating less than 20 percent of the public water supply. Some states, such as Ohio, have high concentrations of naturally occurring fluoride. Importantly, ten to 30 percent of people in Appalachian states, and likely more in rural Appalachian counties, draw from self-supplied water sources without added fluoride.

Two-thirds of Appalachians reported seeing a dentist in the aggregated BRFSS data from 1997-2007, but half reported disease-related tooth loss, and almost one quarter reported losing six or more teeth to disease or decay in 1999-2006. Appalachian areas generally reported more decay-related tooth loss than the rest of the United States, with Northern Appalachian states reporting fewer teeth lost than Southern states. Almost ten percent of Appalachian seniors reported having lost all of their teeth over the eight-year span.

An important take-away from this study is that state-level analyses oversimplify the variations occurring at sub-state levels. To accurately evaluate the status of oral health in the Appalachian Region and recommend the best targeted approaches, ARC will require collection of more and better sub-state data. BRFSS sampling is too small for county-level analyses. However, future BRFSS sample designs that intentionally separate Appalachian and/or rural versus metropolitan subareas of a state would provide better year to year comparisons.

From Surgeon General's Report on Oral Health in America

- Tobacco-related oral lesions are prevalent in adolescents who currently use smokeless tobacco.
- Professional care is necessary for maintaining oral health, yet 25 percent of poor children have not seen a dentist before entering kindergarten.
- Medical insurance is a strong predictor of access to dental care. Uninsured children are 2.5 times less likely than insured children to receive dental care. Children from families without dental insurance are 3 times more likely to have dental needs than children with either public or private insurance. For each child without medical insurance, there are at least 2.6 children without dental insurance.
- Medicaid has not been able to fill the gap in providing dental care to poor children. Fewer than one in five Medicaid-covered children received a single dental visit in a recent year-long study period. Although new programs such as the State Children's Health Insurance Program (SCHIP) may increase the number of insured children, many will still be left without effective dental coverage.
- The social impact of oral diseases in children is substantial. More than 51 million school hours are lost each year to dental-related illness. Poor children suffer nearly 12 times more restricted-activity days than children from higher-income families. Pain and suffering due to untreated diseases can lead to problems in eating, speaking, and attending to learning.

Source: Oral Health in America-a Report of the Surgeon General. U.S. DHHS / NIDCR / NIH. 2000.

2.3.2 ORAL HEALTH INDICATORS AND SOCIOECONOMIC STATUS

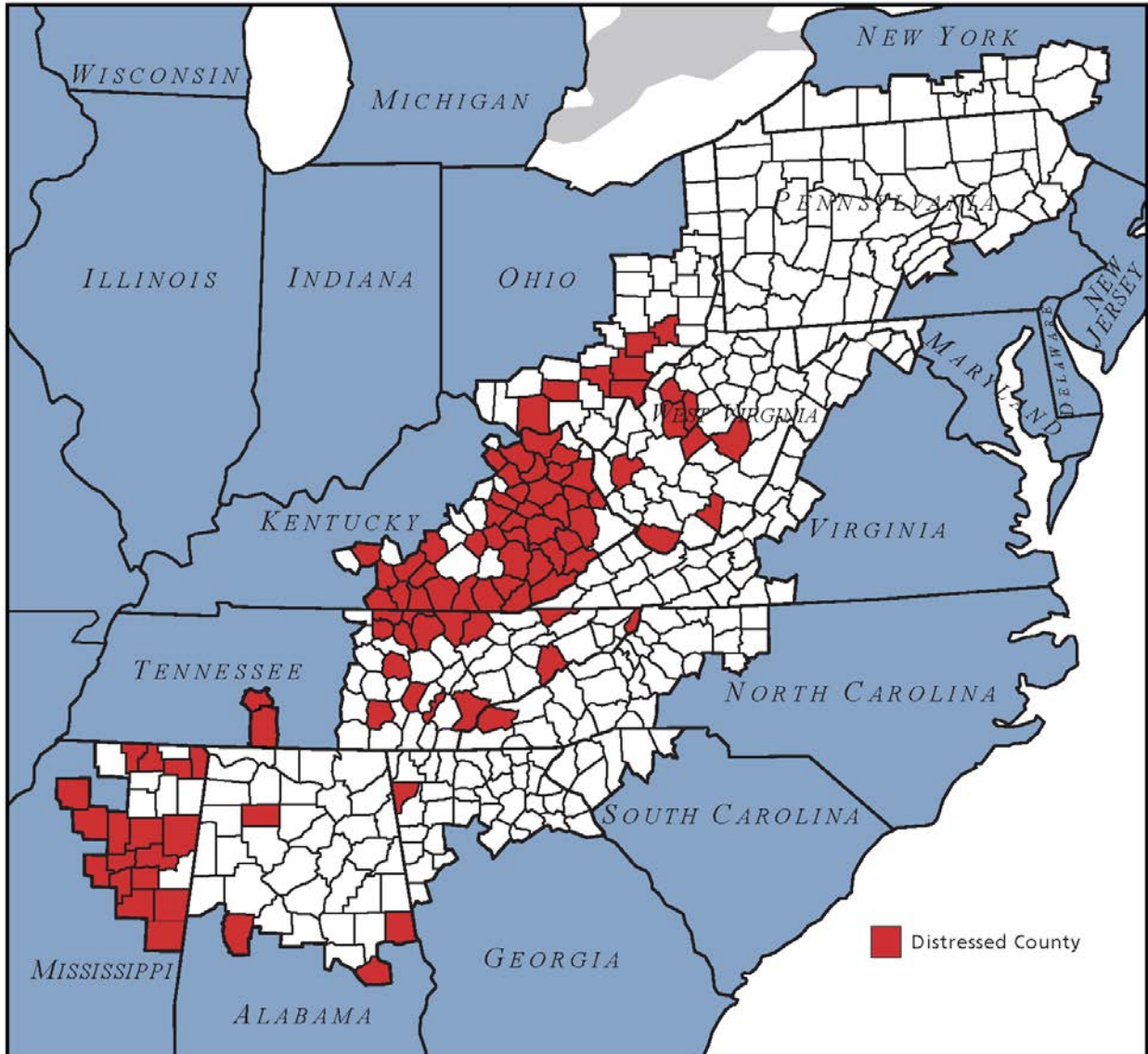
Socioeconomic status (SES) is statistically related to oral health status, as measured in several different ways. This report examines those SES indicators that set Appalachia apart and for which good data were available, including metropolitan versus non-metropolitan status, poverty levels, and—to the extent possible—dental insurance coverage. Other SES indicators, such as percent of school children that receive free or reduced lunch or level of education are not included in this report for lack of data. In general, the Appalachian Region is characterized by high rates of poverty and unemployment, low incomes and a large rural population (Behringer, et al. 2007).

Twice as many people in Appalachia live in rural areas compared to the rest of the U.S. (42 and 20 percent, respectively) (ARC. 2011). The region lags in many health care technological advances, in part because of its more rural nature and high number of uninsured persons (Behringer, Friedell. 2006). Rural areas face more challenges accessing dental care than urban areas. Both workforce size and number of facilities are more limited in rural areas. (Huttinger, Schaller-Ayers, Lawson. 2004: 103). The result is dentists who practice in these areas can be overburdened with patients (Krause, Mosca, and Livingston. 2003). For lower income families, transportation to the few available facilities may not always be feasible (Krause, et al. 2003).

Many non-metropolitan areas have high levels of poverty; and this holds true in Appalachia. The poverty rate in Appalachia exceeded the national average by nearly five percent in 2008 (18 and 13.2 percent, respectively) (U.S. Census Bureau and ARC. 2011). Poverty has long been considered an indicator of poor health in general; however, a study (Hudson, Stockard, Ramberg. 2007) concluded that “[i]n spite of the pervasive cultural images associating poor dental care with poverty, very little of this research has focused on dental and oral health.” However, Dye and colleagues (2007) noted that areas with high poverty levels have a higher incidence of decayed, missing, and filled teeth. Low income is also correlated with other SES indicators such as unemployment and lack of dental insurance, which may also affect oral health status.

Within the Appalachian Region, Central Appalachia has the highest concentration of poverty, with about 21 percent of the population in poverty (Lichter, Campbell. 2005). ARC has designated 82 of the 420 Appalachian counties “distressed” based on high poverty rates, high unemployment rates and low per capita income (ARC. 2011). More than half of these counties are in Kentucky. Unfortunately, there are too few data in this report to make current assessments of relationships between poverty areas and oral health at the sub-state level.

FIGURE 12 – ARC DESIGNATED DISTRESSED COUNTIES, FY 2012



Prepared by the Appalachian Regional Commission.

Data Sources:

Unemployment data: U.S. Department of Labor, Bureau of Labor Statistics, LAUS, 2007-2009
 Income data: U.S. Department of Commerce, Bureau of Economic Analysis, REIS, 2008
 Poverty data: U.S. Department of Commerce, Bureau of the Census, American Community Survey, 2005-2009



Source: Appalachian Regional Commission. www.arc.gov/research.

We can only note that at the Appalachian Region-level, when data in this study were controlled for socioeconomic indicators (SES), geographic differences disappeared. Details on that analysis are contained in Appendix C. Poverty, low income in the community and low levels of insurance in the community correlated with low rates of dental visits. Poverty and rural location correlated with high rates of tooth removal. See Table 27.

Dental care does not receive the same priority as basic medical care for residents in the region and this is attributed to household budget constraints (Huttinger, et al. 2004). Accordingly, children (Flores, Tomany-Korman. 2008) and adults are less likely to have dental insurance than medical insurance (NIH and CDC, 2002). There is also evidence of low utilization of dental services among rural populations covered by Medicaid (Fisher, Mascarenhas. 2007); contributing factors could include scarcity of nearby facilities and practitioners that participate in Medicaid. Please see Chapter 4, Oral Health Insurance Coverage, for further discussion on dental insurance.

The Surgeon General's reports in both 2000 and 2011 draw attention to relationships between diabetes and oral health in Appalachia and the Ozarks, indicating the importance of involving both pediatricians and geriatricians in helping their patients recognize this link to total health maintenance.

2.3.3 ORAL HEALTH OF CHILDREN IN APPALACHIA

For children, poverty is one of the most influential variables on health status (de la Fuente-Hernandez and Acosta-Gio, 2007; Dietrich, et al., 2008; Krol, 2003; Krol and Nedley, 2007; Sabbah, et al., 2007; Selwitz, Ismail and Pitts, 2007; Sgan-Cohen and Mann, 2007). Low-income children are also the least likely group to receive any preventive oral care (Kenney, et al. 2005). In a recent study conducted with 2,183 school children in North Carolina, children with poor oral health status were nearly four times more likely than others to miss school due to dental pain (Jackson, et al. 2011). Absences caused by pain were associated with poorer school performance, but absences for routine care were not (Jackson, et al. 2011). Overall, oral health status was associated with poorer academic performance independent of school absence for pain (Jackson, et al. 2011).

Presenters at the 2011 ARC Conference on Healthy Families, Healthy Future shared experiences indicating that children in Appalachia still face significant dental care and oral health hurdles.

Reporting for **North Central Pennsylvania** Area Health Education Center, Tioga County Partnership for Community Health, Laurel Health System Mansfield University, Tioga County Dental Society and Temple School of Dentistry, Executive Director, **Deborah L. Sawyer**, noted that 90 percent of students at the clinic fail the dental care comprehension exam in seventh grade. The exam tests awareness of good oral health practices. She also observed that having all teeth extracted and dentures made is a rite of passage for many 16-year olds in the clinic's service area. Her program serves 41,981 rural residents in a Dental Health Professional Shortage Area.

Reporting for **Eastern Kentucky**, **Julie Watts McKee**, DMD, State Dental Director, described continued high incidence of dental caries in five- and six-year olds. She described Governor Steve Beshear's campaign to address it by extending Medicaid to Oral Health Coalitions in 12 Eastern Kentucky counties and 13 Eastern Kentucky school systems. She, too, noted that awareness of good dental hygiene practices is as significant as problems with access to providers.

42 percent of children ages 2 to 4 had untreated decay.

Kentucky's Department of Public Health Oral Health Program
Julie Watts McKee 2011

Bobbi Jo Muto noted that in 2005, **West Virginia** ranked lowest in the nation in oral health and highest in tobacco use. At that time, West Virginia's Dental Director worked part time and had limited staff. Working with Marshall University, West Virginia policy makers began to tackle the problem with a program aimed at establishing dental homes for children. The program works with local dentists, focuses on sealants and community education and builds a scorecard on the status of children's oral health.

Shelley Goodall, Mountain Laurel Clinic, Garrett Co., **Maryland** reported a substantial unmet need for dental care among residents of her clinic's service area. Her story illustrates how good statistics from the rest of the state mask problems in Appalachian communities.

2.3.4 IMPLICATIONS

Oral health is tightly tied with population health and productivity. In general, poor oral health is considered a precursor to more serious health conditions, such as cardiovascular disease (Kenney, McFeeters, Yee. 2005). To this point, the CDC has actually identified two of the indicators studied in this report, dental visits and tooth removal, as chronic disease indicators (CDC. 2007).

Safe, effective measures like fluoridation, dental sealants, fluoride rinses, dietary supplements and good personal oral hygiene practices are relatively low cost investments that can reach large numbers of people. Yet, large parts of Appalachian states have lower oral health status than the rest of the country.

Socioeconomic conditions are directly associated with oral health status. Because direct care for purposes of either repair or prevention is costly and poorly covered by public or private health insurance, the best opportunities for improvement in oral health status are community initiatives. Fluoridation, fluoride rinses and public information about good oral health hygiene practices reach more people with smaller investments. Programs for children, even those involving direct care, are aimed at building a foundation of good oral health practices.

