



Public Health Assessment for

OCCURRENCE OF SELECTED HEALTH CONDITIONS
IN OTTAWA COUNTY, OKLAHOMA

EPA FACILITY ID: OKD980629844

SEPTEMBER 30, 2008

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE**

Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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EPA FACILITY ID: OKD980629844

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Executive Summary

A citizen's group reported that in Ottawa County, Oklahoma—where the Tar Creek Superfund site is located—certain diseases and illnesses occur at higher than expected rates, and that report has county residents concerned. The Local Environmental Action Demanded (LEAD) Agency published the report, which it based on a community survey. In this public health assessment the Oklahoma State Department of Health (OSDH) and the Agency for Toxic Substances and Disease Registry (ATSDR) respond to that report and provide residents with scientific information about the health status of their community. This information may be useful in identifying particular adverse health outcomes that are more prevalent in the community as well as in planning health education activities that can reduce disease and illness.

OSDH and ATSDR reviewed information about the occurrence of certain diseases and health conditions in Ottawa County or smaller geographic areas and compared this information with similar data for the state or the nation. Depending upon the disease or the health condition evaluated, population-based datasets were available for specific geographic areas. The geographic areas included Ottawa County, a five-zip code area in Ottawa County closest to the Tar Creek Superfund Site, a seven-county area encompassing the northeast region of Oklahoma, the State of Oklahoma, and the entire United States.

When compared to the state, the occurrence of most diseases or other health conditions in adults evaluated in this public health assessment is similar in Ottawa County. Specifically, in Ottawa County adults the prevalence of asthma, hypertension, arthritis, coronary heart disease, myocardial infarction, stroke, high cholesterol, osteoporosis, diabetes, high blood pressure, serious mental illness, obesity, and smoking is similar to the state.

When compared to the state or nation, the occurrence of most diseases or other health conditions in infants or children in Ottawa County or in the Tar Creek Superfund area is similar to or lower than the state. Specifically, the rates for low-birth weight babies, and preterm babies—as well as the prevalence of hearing loss in newborn infants—are the same or lower in Ottawa County as compared to the state. The prevalence of autism and learning disabilities in children from Ottawa County is similar to the state. Birth defect rates in Ottawa County are lower than the rates in the state for seven of the nine years monitored.

OSDH and ATSDR evaluated death rates from all causes and for some diseases. The age-adjusted death rates in Ottawa County are similar to or lower than the state's death rate for high blood pressure, liver disease, diabetes, atherosclerosis, Alzheimer's disease, and kidney disease. The death rate from heart disease in Ottawa County is higher than the death rate for the state. The higher death rate for heart disease in Ottawa County may be due to chance variation. The overall death rate in Ottawa County is higher than the state, while Ottawa County's and the state's death rates are higher than the national average. The leading causes of death in Oklahoma are heart disease, cancer, stroke, lung disease, and injury.

For the top ten types of cancer, incidence in Ottawa County and in the five zip code area surrounding the Tar Creek Superfund Site is similar to cancer incidence in the state.

In summary, data on several health outcomes for Ottawa County show the occurrence of most diseases and health conditions are similar to or lower than the state, while the occurrence of a few diseases in Ottawa County is higher as compared to the state. Statistical tests indicated, however, that for almost all circumstances, none of these rate differences between Ottawa

County and the state were statistically significant, that is, the rates could not be shown to be truly different.

While the analyses presented in this report cannot be used to determine whether contamination from the Tar Creek Superfund Site directly contributes to disease and death in Ottawa County, the results do indicate that the overall health experience of residents in Ottawa County is similar to the State of Oklahoma.

In November 2006 when the public release version of this report was released, OSDH and ATSDR held public meetings to present the findings of their health outcome data review. In addition, OSDH and ATSDR met with the Ottawa County Health Department to discuss the results of this public health assessment and to determine the need for any health education activities. ATSDR will have discussions with Indian Health Service, American Indian tribes in the area, LEAD Agency, and OSDH to evaluate the feasibility of conducting a health outcome data review focused on American Indians and other people who live in and around the Tar Creek Superfund Site.

Purpose

Residents of Ottawa County are concerned that the occurrence rate of certain diseases and illnesses in their county may be higher than prevailing state or national rates. This public health assessment provides residents with scientific information about the health status of their community. This information may be useful in planning health education activities directed toward reducing disease and illness in the community.

Background

In 2002, a citizen's group known as the Local Environmental Action Demanded (LEAD) Agency, Inc. conducted a community health survey in Ottawa County and released a report summarizing its findings (Jim and Hatley 2004). The LEAD Agency community survey showed increases in several disease outcomes, including asthma, obesity, cancer and hypertension.

The Oklahoma State Department of Health (OSDH) and the Agency for Toxic Substances and Disease Registry (ATSDR) reviewed information regarding the occurrence of certain diseases and health conditions in Ottawa County. That information included comparisons with similar information for the state and for the nation. OSDH and ATSDR also addressed the occurrence of diseases and health conditions assessed in the LEAD Agency report. Depending on the disease or health condition evaluated, we used population-based datasets for specific geographic areas. These areas included Ottawa County, a five zip code area closest to the Tar Creek Superfund area, the northeast region of Oklahoma, the State of Oklahoma, and the United States.

According to the U.S. Census Bureau, in 2005 an estimated 32,866 persons lived in Ottawa County. In 2004, 24% of the population in the county was under 18 years old, while 17% was 65 and older. Just over half (51%) of the county's 2004 population was female. In 2003, approximately 80% of the population was white, 19% was American Indian, and 1% was African American. The median household income in 2003 was \$28,410.

Discussion

This public health assessment process uses the science of epidemiology to study human disease rates; therefore, certain epidemiological terms are used in the report. These terms are defined here:

Prevalence

Disease prevalence is the total number of old and new cases of a disease in a population at a given point in time. For example, the prevalence of diabetes in a population consists of people in a certain geographic area who were ever diagnosed with diabetes.

Incidence

Incidence is the number of newly diagnosed cases of a disease during a specified time period. For example, the yearly incidence of diabetes in a specified geographic area is determined by counting the number of newly diagnosed cases of diabetes in that area for a specified time period, usually a calendar year.

Rates

Rates are the number of diseases or deaths that occur in a certain population size. For example, 5 deaths per 100,000 persons in a particular year is a death rate. Rates for the majority of diseases

are expressed as the number of cases per 100,000 persons, with the exception of more common diseases such as some of those affecting children (e.g., birth defects and learning disabilities). For these more common conditions, rates are typically reported as the number of cases per 1,000 children. In this public health assessment, cancer is reported as an incidence rate, which is the number of new cases diagnosed each year, whereas asthma is reported as a prevalence rate, which is the total number of asthma cases occurring in the population at any given time.

Age adjustment

The rates of almost all causes of disease, injury, and death vary by age. Age adjustment is a technique for “removing” the effects of age from crude rates, thus allowing meaningful comparisons across populations with different underlying age structures. For example, comparing the crude rate of heart disease in Florida to that of California is misleading: the relatively older population in Florida will lead to a higher crude death rate even if the age-specific rates of heart disease in Florida and California are the same. For such comparisons, age-adjusted rates are preferred.

Standardized Incidence Ratios

To evaluate cancer incidence in this public health assessment, we converted the number of observed cases in specific geographic areas to ratios. The use of ratios enabled the comparison of the number of cancer cases in Ottawa County residents or in residents of the five zip code area closest to the Tar Creek Superfund Site with a reference population—the State of Oklahoma—to determine a possible excess in cancer. Using ratios, the observed number of cancers was compared with “expected” numbers. The expected number of cases was based on cancer incidence data for the State of Oklahoma. As described in the previous section, the ratio of observed to expected cases, known as a standardized incidence ratio (SIR), was adjusted for age. SIRs were calculated by dividing the number of observed cancer cases by the expected number of cases. The expected number of cases for each type of cancer was generated using Oklahoma age-specific cancer data from the state’s cancer registry. Age categorization by 5-year intervals (0–4, 5–9, 10–14, ... 80–84, 85+) was used in computing SIRs. If the observed number of cases equaled the expected number of cases, the SIR equaled one (1.0). When the observed number of cases was higher than the expected number of cases, the SIR was greater than one (1.0), indicating an increase in cancer incidence within the geographic area of concern.

95% Confidence Intervals

Chance variation can influence calculations of various incidence rates, prevalence rates, and rate ratios, particularly when looking at the occurrence of conditions in small populations, such as Ottawa County and the five zip code area closest to the Tar Creek Superfund Site. Statisticians, however, have developed methods to take this chance variation into account. Statistically significant findings are evaluated using a 95% confidence interval (CI). The 95% CI determines the probability that a rate or a rate ratio greater or smaller than 1.0 stems from chance alone. If the 95% CI includes 1.0, then the rate or rate ratio is not considered to be statistically significant and may be due solely to chance. Similarly, we can validly compare the CIs for two different rates or rate ratios describing the same condition in two different populations to determine any significant differences between the two.

Organization of the Public Health Assessment

The discussion section of the public health assessment is presented in several sections. The first briefly describes the sources of information for disease and health conditions in Oklahoma. The second presents the ATSDR/ OSDH results and conclusions in plain language. The third section describes the technical basis for the results and conclusions. While the third subsection is more technical than are others, we have attempted to describe the technical issues and evaluation in a way that most people will understand. The final section describes the strengths and limitations of our review. The titles of the subheadings are

- Statewide information about diseases and health conditions,
- Results and conclusions for various diseases, health conditions, and deaths,
- Technical evaluation of diseases, health conditions, and deaths, and
- Strengths and limitations.

Statewide Information about Diseases and Health Conditions

The OSDH maintains several surveillance systems or other programs that generate population-based information regarding health conditions. The data from these surveillance systems allow comparison of disease rates and health conditions in Ottawa County or other, small geographic areas with the disease rates and health conditions for Oklahoma or, in some cases, the entire United States. These information sources are described briefly below.

Behavioral Risk Factor Surveillance System

The Behavioral Risk Factor Surveillance System (BRFSS) is a national telephone survey designed to collect population-based health information from the general public. This is a project funded by the Centers for Disease Control and Prevention (CDC) and is accessed at <http://www.cdc.gov/brfss/index.htm> (BRFSS 2006). Oklahoma's BRFSS contains information about arthritis, asthma, diabetes, hypertension (high blood pressure), smoking, and obesity in adults. The BRFSS data used in this public health assessment were collected in 2005. During 2005, several county-specific BRFSS interviews were completed, and Ottawa County was one of the counties included in this data collection effort.

Vital Statistics

Oklahoma's vital records contain information about all causes of deaths, including deaths due to diabetes, Alzheimer's disease, chronic liver disease, kidney disease, hypertension (high blood pressure), atherosclerosis (a disease of the arteries), and heart disease. This report uses Oklahoma's vital records data for the years 1999 to 2003.

Cancer Registry

Oklahoma's cancer registry contains information about new cases of cancer diagnosed each year. The cancer registry has been in existence since 1997. This report uses Oklahoma's cancer registry data for the years 1997 to 2003.

Birth Defects Registry

Oklahoma's birth defects registry contains information about birth defects reported to the state each year. The birth defects registry has been in existence since 1994. This report uses Oklahoma's birth defects registry data for the years 1994 to 2002.

Newborn Screening Program

Oklahoma's newborn screening program collects information about hearing in newborn children throughout the state. This report uses Oklahoma's newborn screening data collected between August 2002 and July 2004.

Special Education

Oklahoma's special education child count program contains annual information about autism, specific learning disabilities, and other health impaired conditions. This report uses information collected by the Oklahoma State Department of Education from 2002 and 2003.

Department of Mental Health and Substance Abuse Services

Information about mental illness comes from a 1999 survey conducted by Oklahoma Department of Mental Health and Substance Abuse Services.

Other Data Sources

Information about birth weight and premature birth during the years 1999 to 2002 comes from several sources, including OSDH Maternal and Child Health Service, OSDH Center for Health Statistics, and the U.S. Department of Health and Human Services' National Center for Health Statistics. This public health assessment uses data on birth weight and premature birth for the years 1999 to 2002

Results and Conclusions for Various Diseases, Health Conditions, and Deaths

Key findings about the occurrence of various diseases, health conditions, and deaths in Ottawa County or the small geographic areas surrounding the Tar Creek Superfund Site are included in this subsection. More information about these findings can be found in the Technical Evaluation of Diseases and Health Conditions subsection.

Cancer

Information about the number of new cancer cases (i.e., cancer incidence) in Ottawa County comes from the Oklahoma Central Cancer Registry. ATSDR and OSDH compared the average number of new cancer cases from 1997 to 2003 for Ottawa County and for the five-zip code area near the Tar Creek Superfund Site. For the top 10 cancers, the age-adjusted cancer rates for Ottawa County and for the 5-zip code area are similar to the state (see Tables 3 and 4).

Arthritis

Information about arthritis in Ottawa County comes from Oklahoma's BRFSS. In Ottawa County, 32 out of every 100 adults surveyed report having arthritis, while 30 out of every 100 adults in Oklahoma report having arthritis. The prevalence of arthritis in Ottawa County is therefore similar to that of the state.

Hypertension

Information about hypertension (high blood pressure) in Ottawa County comes from Oklahoma's BRFSS. In Ottawa County, 36 out of every 100 adults report having hypertension, while 30 out of every 100 adults in Oklahoma report having hypertension. The prevalence of hypertension in Ottawa County is similar to the state prevalence.

Information about deaths in Ottawa County from hypertension is available from the state's vital records. From 1999 to 2003, Ottawa County reported 23 deaths from hypertension.

When adjusted for age differences between Ottawa County and the state, the death rate from hypertension in Ottawa County is 12 deaths for every 100,000 persons compared to the state rate of 12 deaths for every 100,000. The death rate from hypertension in Ottawa County is the same as the state.

Smoking

Information about smoking in Ottawa County comes from Oklahoma's BRFSS. In Ottawa County, 29 out of every 100 adults are smokers; in Oklahoma, 25 out of every 100 adults identify themselves as smokers. While a small difference appears for smokers in Ottawa County, because of the small Ottawa County population, determination of an actual difference is not possible. The difference is likely due to chance variation.

Obesity

Information about obesity in Ottawa County comes from Oklahoma's BRFSS. In Ottawa County, 26 out of every 100 adults report some obesity, while 26 out of every 100 adults in Oklahoma report obesity. The occurrence of obesity in Ottawa County is identical with the state.

Asthma

Information about asthma in Ottawa County comes from Oklahoma's BRFSS. In Ottawa County, 17 out of every 100 adults reported having asthma, while 13 out of every 100 adults in Oklahoma reported having asthma. A mathematical analysis shows that the difference in rates for Ottawa County and the state is likely due to chance variation.

Diabetes

Information about diabetes in Ottawa County comes from Oklahoma's BRFSS. In Ottawa County, 10 out of every 100 adults in Ottawa County report having diabetes, while 9 out of every 100 adults in Oklahoma report having diabetes. The prevalence of adult diabetes in Ottawa County is similar to the state.

From 1999 to 2003, Ottawa County reported 62 deaths from diabetes. The death rate from diabetes in Ottawa County is 30 deaths for every 100,000 persons compared to the state rate of 28 deaths for every 100,000. The death rate from diabetes in Ottawa County is similar to the death rate for the state.

Alzheimer's Disease

Information about Alzheimer's disease in Ottawa County comes from Oklahoma's vital records. From 1999 to 2003, Ottawa County reported 26 deaths from Alzheimer's disease. The death rate from Alzheimer's in Ottawa County is 13 deaths for every 100,000 persons compared to the state rate of 19 deaths for every 100,000. A mathematical analysis showed that the difference in the death rates from Alzheimer's in Ottawa County compared to the state is probably due to chance variation.

Liver Disease

Information about liver disease in Ottawa County comes from Oklahoma's vital records. From 1999 to 2003, Ottawa County reported 17 deaths from liver disease. The death rate from liver

disease in Ottawa County is 10 deaths for every 100,000 persons compared to the state rate of 10 deaths for every 100,000. The death rate from liver disease in Ottawa County is the same as the state's death rate for liver disease.

Kidney Disease

Information about kidney disease in Ottawa County comes from Oklahoma's vital records. From 1999 to 2003, Ottawa County reported 25 deaths from kidney disease. The death rate from kidney disease in Ottawa County is 12 deaths for every 100,000 persons compared to the state rate of 14 deaths for every 100,000. A mathematical analysis showed that the small difference in the deaths from kidney disease in Ottawa County compared to the state is probably due to chance variation.

Atherosclerosis

Information about atherosclerosis (a disease of the arteries) in Ottawa County comes from Oklahoma's vital records. From 1999 to 2003, Ottawa County reported 24 deaths from atherosclerosis. The death rate from atherosclerosis in Ottawa County is 12 deaths for every 100,000 persons compared to the state rate of 11 deaths for every 100,000. A mathematical analysis showed that the small difference in the deaths from atherosclerosis in Ottawa County compared to the state is probably due to chance variation.

Heart Disease

Information about heart disease in Ottawa County comes from Oklahoma's vital records. From 1999 to 2003, Ottawa County reported 513 deaths from heart disease. The death rate from heart disease in Ottawa County is 248 deaths for every 100,000 persons compared to the state rate of 225 deaths for every 100,000. A mathematical analysis showed that the small difference in the deaths from heart disease in Ottawa County compared to the state could be due to chance variation.

Birth Weight and Premature Birth

Information about birth weight and premature birth comes from the Maternal and Child Health Service and the Center for Health Statistics of the Oklahoma State Department of Health, and the National Center for Health Statistics. For 1999 to 2002, the rate of low birth weight babies in Ottawa County was 6.7%, which is lower than the national rate and the Oklahoma rate of 7.7%. From 1999 to 2002, the rate of preterm births in Ottawa County was 7.9% compared to the national rate of 11.9% and the Oklahoma rate of 9.8%. In Ottawa County, the occurrence of low birth weight babies and preterm babies is lower than the state and national rates.

Newborn Hearing

ATSDR and OSDH also evaluated information from the Oklahoma State Newborn Hearing Screening program on hearing loss in newborn infants who lived in Ottawa County from August 2002 to July 2004. Of the 633 infants examined from Ottawa County, the occurrence of hearing loss was similar to the state and national average of one to three infants with hearing loss for every 1,000 births.

Mental Illness

Data were not available for the occurrence of mental illness in Ottawa County. Data, however, were available from the Oklahoma Department of Mental Health and Substance Abuse Services

for the seven counties that make up the northeast region of Oklahoma. The rate of serious mental illness in the seven counties in the northeast region is 3.2% (or 3.2 cases for every 100 adults) compared to 3.3% (or 3.3 cases for every 100 adults) statewide. The occurrence of serious mental illness in northeast Oklahoma is thus identical to that of the state.

Special Education

The Oklahoma State Department of Education maintains a statewide database with information about children with disabilities who are eligible for special education services. ATSDR and OSDH used this database to evaluate the occurrence of children with autism, learning disabilities, and other health impairments for 2002 and 2003.

Autism -- In 2002 and again in 2003, seven children in Ottawa County were reported with autism compared to 806 in 2002 and 844 in 2003 for the State of Oklahoma. The 2002 and 2003 rate of autism in Ottawa County for every 1,000 children was 1.2. These rates compare to the statewide rate for autism of 1.3 in 2002 and 1.4 in 2003. The occurrence of autism in Ottawa County children is similar to the state.

Learning Disability – In Ottawa County, 444 children in 2002 and 469 children in 2003 were reported with learning disabilities. Statewide, 45,485 children in 2002 and 46,417 children in 2003 were reported with learning disabilities. In 2002, the rate of learning disabilities in Ottawa County for every 1,000 children was 73—the same as the state. In 2003, the rate of learning disabilities in Ottawa County children was 77 for every 1,000 children, which is similar to the 2003 statewide rate of 74 for every 1,000 children. The occurrence of learning disabilities in Ottawa County children is similar to the state.

Other Health Impairments – The Individuals with Disabilities Education Act defines other health impairments as limited strength, vitality, or alertness in the educational environment that adversely affects a child’s educational performance. Conditions such as asthma, attention deficit disorder, diabetes, epilepsy and leukemia are included in this special education category. In Ottawa County, 21 children in 2002 and 24 children in 2003 were reported with such other health impairments. Statewide, 4,108 children in 2002 and 4,816 children in 2003 were reported with other health impairments. The rate of other health impairments for every 1,000 children in Ottawa County was 3.5 in 2002 and 4 in 2003. The rate in Ottawa County was lower than the state rate of 6.6 in 2002 and 7.7 in 2003 for every 1,000 children.

Birth Defects

ATSDR and OSDH evaluated the occurrence of birth defects in Ottawa County by comparing the number of birth defects per 1,000 live births for Ottawa County to the state number. Ottawa County averaged 1,800 births yearly and reported each year somewhere between 3 to 12 children born with birth defects.

From 1994 to 2000, the rate of birth defects in Ottawa County ranged from 7 to 30 birth defects for every 1,000 births. The rate of birth defects in Ottawa County was lower than the statewide yearly rate of 30 to 40 birth defects for every 1,000 births over the same period. The wide variation in the rate of birth defects in Ottawa County is probably due to the small number of births in the county.

For the 9-year period evaluated, Ottawa County had a higher birth defects rate for 2 of the years considered (2001 and 2002). Ottawa County reported 22 birth defects in 2001 and 17 birth defects in 2002. The birth defects rate in Ottawa County in 2001 was 50 for every 1,000 live

births, and in 2002, the rate was 42 for every 1,000 live births. The birth defects rate in Ottawa County for 2001 and 2002 was higher than the statewide birth defects rate of 40 per 1,000 live births in 2001 and 37 per 1,000 live births in 2002. While during the 2-year period from 2001–2002 the birth defects rate in Ottawa County was higher than the state, the overall birth defects trend for the 9-year period in Ottawa County was much lower than that for the state.

Death Rate

ATSDR and OSDH evaluated the death rate for Ottawa County for 1999 to 2003. The average death rate per 100,000 people was 1,055 for Ottawa County, which can be compared to the average death rate of 973 for Oklahoma and the average death rate of 855 for the United States. Oklahoma's leading causes of death are heart disease, cancers, injuries, stroke, and chronic obstructive pulmonary disease. Oklahomans and residents of Ottawa County die from these causes at a higher rate than the rest of the nation. Smoking is one of the primary risk factors for all of these diseases. According to BRFSS, the 25% of Oklahoma adults who currently smoke is 5th-highest the nation. Ottawa County is ranked 10th in the state, at 29% of adults who currently smoke. The high smoking levels in the state and county most likely account for a large proportion of these diseases.

Technical Evaluation of Diseases, Health Conditions, and Deaths

Behavioral Risk Factors Surveillance System

ATSDR and OSDH reviewed the state's 2005 BRFSS information to evaluate the prevalence of arthritis, asthma, coronary heart disease, myocardial infarction, stroke, high cholesterol, osteoporosis, diabetes, hypertension, smoking, and obesity in adults living in Ottawa County and in the State of Oklahoma (Table 1). To determine whether the prevalence rates for these conditions were truly higher in Ottawa County when compared to the state, we generated 95% confidence intervals. We then compared these confidence intervals to check for overlaps in the estimates. Any overlap in confidence intervals for the same condition indicated no statistical differences in the prevalence rates. For example, 32.26% (95% CI, 27.38 – 37.15) of the people in Ottawa County reported having arthritis, while 30.27% (95% CI, 29.04 – 31.50) in the State of Oklahoma reported having arthritis. In this comparison the confidence intervals overlapped; the prevalence rates were therefore considered the same or similar, even though the point estimates were not identical (i.e., 32.26% compared to 30.27%).

The evaluation of overlapping confidence intervals to determine the statistical significance between two point estimates is a different approach when compared to the use of these estimates in analyzing cancer incidence in this public health assessment (see description of 95% confidence intervals on page 2). This is, however, a valid approach when assessing the difference between two point estimates (Schenker and Gentleman, 2001).

The prevalence of many health conditions identified in the 2005 BRFSS was higher in Ottawa County than in the state (see Table 1). Still, while most conditions had a higher prevalence, the confidence intervals for the county and the state overlapped. Consequently, these differences were likely due to chance variation and did not indicate real differences between the two populations. Two conditions—high cholesterol and obesity—had lower prevalence rates in Ottawa County when compared to the state rate. Nevertheless, as with the higher prevalence conditions, no statistical difference appeared between the county and state.

Table 1. Disease Prevalence in Ottawa County and Oklahoma; 2005 BRFSS

<i>Disease</i>	<i>Ottawa County</i>		<i>Oklahoma</i>	
	Prevalence	95% CI*	Prevalence	95% CI*
Arthritis	32.26%	27.38 – 37.15	30.27%	29.04 – 31.50
Asthma	17.11%	12.43 – 21.49	13.25%	12.25 – 14.26
Coronary Heart Disease	5.39%	3.51 – 7.26	4.95%	4.42 – 5.47
Myocardial Infarction	6.23%	4.12 – 8.35	5.29%	4.74 – 5.84
Stroke	5.40%	3.17 – 7.62	3.57%	3.13 – 4.01
High Cholesterol	56.08%	49.26 – 62.89	61.75%	60.24 – 63.25
Osteoporosis	6.20%	4.21 – 8.18	5.02%	4.53 – 5.51
Diabetes	9.58%	6.69 – 12.47	8.94%	8.21 – 9.67
Hypertension	36.31%	30.96 – 41.67	29.79%	28.56 – 31.03
Smoking	29.06%	23.70 – 34.43	25.00%	23.65 – 26.34
Obesity	25.82%	20.88 – 30.77	25.83%	24.53 – 27.12

CI = Confidence Interval

Vital Statistics

ATSDR and OSDH used Oklahoma's vital statistics from 1999 to 2003 to determine the death rate from various diseases. The categories evaluated are similar to the categories reported in the LEAD Agency report and included

- diabetes,
- Alzheimer's disease,
- chronic liver disease,
- kidney disease (specifically, nephritis and nephritic syndrome),
- hypertensive heart disease with or without kidney disease,
- atherosclerosis(a disease of the arteries), and
- ischemic heart disease (heart attacks).

Because age structures of the populations under analysis can affect death rates, we age-adjusted the death rate for Oklahoma and Ottawa County. The number of deaths in Ottawa County and in the state was reported, together with the age-adjusted death rate per 100,000 persons. Table 2 shows the number of deaths for various disease categories and the age-adjusted death rate in Ottawa County and Oklahoma. The death rate in Ottawa County was slightly higher than in the state for diabetes (29.8 vs. 28.2), atherosclerosis (11.9 vs. 10.7) and ischemic heart disease (248 vs. 225). The death rate in Ottawa County was slightly lower than the state for Alzheimer's disease (12.5 vs. 18.6), liver disease (9.6 vs. 10.2), kidney disease (11.9 vs. 14.2), and hypertensive disease (11.8 vs. 12.2). The small variation in death rates for various categories is typical when comparing rates in small geographic regions (e.g., a county) to the state rate. Accordingly, the slightly higher death rates in Ottawa County for diabetes, atherosclerosis and heart disease are probably due to chance variation. The slightly lower death rates for Alzheimer's, liver disease, kidney disease, and hypertensive disease are most likely also due to chance variation.

Table 2. Age-adjusted Death Rate in Ottawa County and Oklahoma; 1999 to 2003

<i>Disease</i>	<i>Ottawa County</i>		<i>Oklahoma</i>	
	Deaths	Age-Adjusted Death Rate	Deaths	Age-Adjusted Death Rate
Diabetes mellitus (Disease codes E10-E14)	62	29.8	5,082	28.2
Alzheimer's disease (Disease code G30)	26	12.5	3,395	18.6
Chronic liver disease and cirrhosis (Disease codes K70, K73-K74)	17	9.6	1,812	10.2
Kidney disease: nephritis, nephritic syndrome and nephritis (Disease codes N00-N07, N17-N19, N25-N27)	25	11.9	2,577	14.2
Hypertension (Disease codes I10 - I13)	23	11.8	2,207	12.2
Atherosclerosis (Disease code I70)	24	11.9	1,958	10.7
Ischemic heart diseases (Disease codes I20-I25)	513	248.0	40,756	224.7

Cancer Registry

The Oklahoma Central Cancer Registry, through data exchange agreements and assistance from tribal health services facilities in the state, makes every effort to assure that all cancers diagnosed and treated in Oklahoma are registered. Data exchange agreements are in place with Cherokee Nation Cancer Registry as well as the states of Missouri, Arkansas, Kansas, Texas, and others. Moreover, several tribal health facilities in eastern Oklahoma report their cancers directly to the Oklahoma Central Cancer Registry. Pathology laboratories and all other contract health services report directly to the registry.

Cancer – Age-adjusted Incidence Rates

ATSDR and OSDH evaluated the Oklahoma Central Cancer Registry data to determine whether cancer rates near the Tar Creek Superfund Site were significantly higher than those for the state. Because cancer cases can be identified by zip code of residence, it is possible to determine cancer rates for geographic areas smaller than the county. In this case, to calculate the cancer incidence for the ten most incident cancers, we used the number of new cancer cases in the five zip codes closest to the Tar Creek Superfund Site. These zip codes included 74339, 74354, 74358, 74360 and 74363 (see Figure 1, Appendix A). The rates for various cancers are adjusted for age. To simplify comparison to state rates, the yearly cancer incidence rate for each cancer from 1997 to 2003 was averaged to provide one cancer rate for each type of cancer. Table 3 shows the average age-adjusted incidence rates of specific cancers for the five zip code area encompassing the Tar Creek Superfund Site, Ottawa County, and the state.

When comparing the five zip code area near the Tar Creek Superfund Site and Ottawa County to the State of Oklahoma and when using age-adjusted incidence rates, all but one of the 10 most common cancers evaluated were similar. The difference in occurrences for each specific cancer

within the three different geographic areas was evaluated by determining whether the 95% confidence intervals overlapped. Using these evaluations, esophageal cancer was the only cancer that appeared to occur at a higher rate in the five zip code area or in Ottawa County when compared to the state cancer rate. Because the comparison of overlapping confidence intervals is a crude method for evaluating the difference in cancer outcomes in various populations and because it can overestimate a difference when one is not actually present, standardized incidence ratios were calculated (Table 4). Standardized incidence ratios indicated that when comparing the Tar Creek Superfund Site and Ottawa County to the State of Oklahoma, esophageal cancer was not significantly elevated.

Table 3. Average Age-adjusted Cancer Incidence Rates for the five zip code area, Ottawa County, and Oklahoma; 1997–2003

<i>Cancer Site</i>	<i>five zip code area</i>		<i>Ottawa County</i>		<i>Oklahoma</i>	
	IR ⁺	95% CI [*]	IR ⁺	95% CI [*]	IR ⁺	95% CI [*]
Female Breast	131.8	110.0 – 153.6	131.1	111.8 – 150.8	128.7	126.8 – 130.7
Male Prostate	95.0	75.1 – 114.9	93.6	76.4 – 110.8	147.8	145.5 – 150.1
Lung & Bronchus	87.3	74.8 – 99.7	85.5	74.7 – 96.2	83.7	82.5 – 84.8
Colorectal	62.4	52.0 – 72.8	63.6	54.3 – 72.9	53.7	52.8 – 54.6
Non-Hodgkin's Lymphoma	19.7	13.8 – 25.7	19.3	14.0 – 24.5	18.0	17.5 – 18.6
Urinary Bladder	18.5	12.8 – 24.1	17.4	12.6 – 22.2	18.4	17.9 – 19.0
Cervix Uteri (females)	18.5	9.8 – 27.2	17.4	10.0 – 24.9	10.4	9.8 – 11.0
Melanomas of the Skin	15.2	9.8 – 20.7	13.3	8.8 – 17.7	12.3	11.9 – 12.8
Uterus	14.8	7.8 – 21.9	12.8	7.1 – 18.5	20.0	19.2 – 20.7
Kidney & Renal Pelvis	13.8	8.8 – 18.9	12.9	8.7 – 17.1	12.6	12.2 – 13.1
Esophagus	10.0	8.5 – 14.1	8.1	4.8 – 11.4	4.4	4.1 – 4.7

+ IR = Incidence Rate (age-adjusted)

* CI = Confidence Interval

Cancer – Standardized Incidence Ratios

Another way to evaluate cancer in a community is to generate standardized incidence ratios to compare the reported (or observed) number of cancer cases in that community with the expected number of cancer cases. The expected number of cancer cases is calculated by using the age distribution in the area of concern (the five zip code area and the county) and the cancer data from the reference population (the state). This process takes into account the difference in the age structure of the two populations and enables direct comparison between the population of concern and the reference population. Using Oklahoma's Central Cancer Registry data, we ascertained the number of new cancers from 1997 to 2003 for the five zip code area surrounding the Tar Creek Superfund Site and for Ottawa County. In Table 4, the number of new cancer cases diagnosed between 1997 and 2003 is reported as observed, while the expected number of cancer cases is estimated using the incidence rate for each type of cancer and the population age structure based on the 2000 census and standardized to the State of Oklahoma. When compared

to the State of Oklahoma, none of the cancers evaluated in the five zip code area or in Ottawa County were significantly different.

Table 4. Standardized Incidence Ratios (SIR) for Cancers in the five zip code area and Ottawa County; 1997 – 2003

<i>Cancer Site</i>	<i>five zip code area</i>		<i>Ottawa County</i>	
	SIR ⁺	95% CI*	SIR ⁺	95% CI*
Female Breast	1.24	0.58 – 1.81	1.22	0.62 – 1.72
Male Prostate	0.72	0.24 – 1.19	0.74	0.29 – 1.16
Lung & Bronchus	1.14	0.57 – 1.62	1.17	0.64 – 1.59
Colorectal	1.35	0.60 – 2.02	1.09	0.48 – 1.62
Non-Hodgkin's Lymphoma	0.81	0.07 – 1.96	0.82	0.11 – 1.81
Urinary Bladder	1.13	0.19 – 2.35	1.11	0.24 – 2.15
Cervix Uteri (females)	2.14	0.06 – 6.25	2.07	0.12 – 5.48
Melanomas of the Skin	1.51	0.18 – 3.40	1.31	0.18 – 2.86
Uterus	0.78	0.02 – 2.39	0.72	0.02 – 2.05
Kidney & Renal Pelvis	1.10	0.09 – 2.74	1.13	0.14 – 2.54
Esophagus	2.45	0.11 – 6.71	2.02	0.10 – 5.44

+ SIR = Standardized Incidence Ratio

* CI = Confidence Interval

Birth Defects Registry

ATSDR and OSDH evaluated the state's Birth Defect Registry for the years 1994 to 2002. Table 5 shows the number and rate of birth defects for Ottawa County and the State of Oklahoma. From 1994 to 2000, Ottawa County had a lower rate of birth defects compared to the state rate. For example, in 1994 the rate of birth defects was 28.4 for every 1,000 live births compared to a birth defect rate of 40.1 for the state. The range of birth defects rates for Ottawa County during these years was 6.6 to 29.8 for every 1,000 live births, while the range of birth defects rates for the state was 36 to 41 for every 1,000 live births. The wide variation in Ottawa County's birth defect rates is most likely due to the smaller population in the county. During this period, the number of birth defects each year ranged from 3 to 12. The rate of birth defects in Ottawa County is easily affected by a small change in the actual number of birth defects reported. The wide variation in the rate of birth defects for a small population in Ottawa County makes it difficult to draw firm conclusions about whether changes in birth defects rates at the county level are significant.

The rate of birth defects in Ottawa County for 2001 (50 per 1,000 live births) and 2002 (42 per 1,000 live births) are higher than the state birth defects rates for 2001 (40.5 per 1,000 live births) and 2002 (37.2 per 1,000 live births)(see Table 5). While during this 2-year period from 2001–2002 the Ottawa County birth defects rate was higher than the state, the overall birth defects trend for the 9-year period in Ottawa County was much lower than that for the state.

Table 5. Number and Rate of Birth Defects in Ottawa County and the State for In-State Births

<i>Year</i>	<i>Oklahoma</i>			<i>Ottawa County</i>		
	Number of Birth Defects	Number of Live Births	Rate of Birth Defects per 1,000 births*	Number of Birth Defects	Number of Live Births	Rate of Birth Defects per 1,000 births*
1994	1,827	45,607	40.1	8	282	28.4
1995	1,840	45,365	40.6	8	403	19.9
1996	1,835	46,133	39.8	12	403	29.8
1997	1,836	48,160	38.1	9	450	20.0
1998	1,811	49,354	36.7	3	458	6.6
1999	1,848	48,470	38.1	6	461	13.0
2000	2,007	49,380	40.6	6	457	13.1
2001	2,025	50,029	40.5	22	440	50.0
2002	1,872	50,310	37.2	17	405	42.0

* Rates were calculated using live births and still births in the numerator and live births in the denominator. This is the method used by the National Birth Defects Prevention Network for reporting national birth defects rates.

ATSDR and OSDH also obtained information about parents who live in Oklahoma but had their babies in another state. For the state, the number of out-of-state births each year ranges from 1,168 to 1,602 births. For Ottawa County, the number of out-of-state births ranges from 60 to 120 births. These out-of-state births have been added to the in-state births, and the birth defects rate for Ottawa County and Oklahoma has been recalculated.

Table 6 shows birth defects in Ottawa County and the state after including out-of-state births, which are shown in parentheses in the table. The birth defects rate in Ottawa County shows the same pattern as previously described. From 1994 to 2000, the range of birth defects rates in Ottawa County was 6.6 to 20.9, while the range for the state was 36.2 to 39.8 birth defects for every 1,000 live births. In 2001 and 2002, the rate of birth defects in Ottawa County was higher than the state (49.9 versus 41.9 in 2001 and 40.1 versus 36.8 in 2002 for every 1,000 live births). Because the county's small population is probably the cause of the wide range of birth defects rates, no firm conclusions can be drawn about the lower and higher rates of birth defects in Ottawa County.

Newborn Screening Program

Using information from Oklahoma's Newborn Hearing Screening Program, ATSDR and OSDH evaluated hearing tests of Ottawa County infants born from August 1, 2002 through July 31, 2004. Hearing tests occur in two stages. The first stage consists of an initial screening test at birth. If the infant is suspected of having hearing problems, the infant is referred for confirmatory hearing tests. Screening test results are available for 464 of the 540 infants born in Ottawa County and for 169 Ottawa County infants born outside the county. Table 7 shows screening test

results for these 633 infants who lived in Ottawa County at the time they were discharged from the birthing facility.

Table 6. Number and Rate of Birth Defects in Ottawa County and the State for In-state and Out-of-state Births

<i>Year</i>	<i>Oklahoma</i>			<i>Ottawa County</i>		
	Number of Birth Defects	Number of Live Births (out-of-state births)	Rate of Birth Defects per 1,000 births *	Number of Birth Defects	Number of Live Births (out-of-state-births)	Rate of Birth Defects per 1,000 births *
1994	1,827	46,395 (1,302)	39.4	8	382 (60)	20.9
1995	1,840	46,078 (1,168)	39.9	8	383 (65)	20.9
1996	1,835	46,840 (1,545)	39.8	12	403 (81)	29.8
1997	1,836	48,717 (1,473)	37.7	9	450 (99)	20.0
1998	1,811	49,984 (1,452)	36.2	3	458 (120)	6.6
1999	1,848	49,631 (1,594)	37.2	6	463 (101)	13.0
2000	2,007	50,424 (1,575)	39.8	6	459 (107)	13.1
2001	2,025	50,504 (1,602)	40.1	22	441 (95)	49.9
2002	1,872	50,927 (1,550)	36.8	17	406 (80)	41.9

* Rates were calculated using live births and still births in the numerator and live births in the denominator. This is the method used by the National Birth Defects Prevention Network for reporting national birth defects rates.

Of the 464 infants born in Ottawa County, at the initial screening 36 (7.7%) were suspected of having hearing problems in one or both ears and were referred to an outpatient clinic for confirmatory testing. Eighteen (18) infants passed outpatient rescreening, and 17 infants were lost to follow up. Of the 169 infants born outside Ottawa County who live in the county, at the initial screening 5 (2.9%) infants were suspected of having hearing problems in one or both ears and were referred for confirmatory testing.

For 2002 and 2003, the referral rate for all Oklahoma newborns (about 50,000 births per year) was between 3 and 4%. According to the National Center for Hearing Assessment and Management (NCHAM), the expected referral rates for newborn hearing screening programs using Auditory Brainstem Response (ABR) screening equipment averages between 3% and 8% nationally.

The Integris Baptist Regional Health Center in Miami, Oklahoma, experienced technical problems with their ABR screening equipment from November 2003 to April 2004. During this 5-month period, 16 referrals for follow-up confirmatory testing were made. These additional referrals may explain the elevated referral rate (7.7%) for infants initially screened in Ottawa County in comparison with other Oklahoma birthing facilities. The screening referral rate for children who live in Ottawa County is similar to the referral rate for Oklahoma and the nation.

Using information from NCHAM, the rate of confirmation of infants with diagnosed hearing loss in Ottawa County is similar to the national average: out of every 1,000 births, one to three infants are diagnosed with hearing loss.

Table 7. Hearing Tests for Resident Ottawa County Infants; August 2002 to July 2004

<i>County of Birth</i>	<i># Infants Initially Screened</i>	<i># Infants Referred for Confirmatory Testing</i>	<i># Infants Diagnosed with Hearing Loss</i>	<i># Infants Who Passed Confirmatory Testing</i>	<i># Infants Lost to Follow-up</i>
Inside Ottawa County	464	36	*	18	17
Outside Ottawa County	169	5	*	*	*

*Cell size less than 5 suppressed

Special Education

Oklahoma's special education child count contains information about autism, specific learning disabilities, and other health-impairment conditions for 2002 and 2003. Table 8 reports information for 2002 and shows the number of children enrolled in school in Ottawa County and in the state with autism, learning disabilities, and other health impairments. To determine if the occurrence of these conditions in Ottawa County is different from those in the state, we calculated the number of cases per 1,000 children (or the rate). In 2002, Ottawa County had seven children with autism. The rate of autism in Ottawa County is 1.2 cases for every 1,000 children, which is similar to the statewide rate of 1.3 cases for every 1,000 children. The 2002 rate of learning disabilities in Ottawa County is the same as in the state (73 cases for every 1,000 children). The 2002 rate of children with other health impairments is lower in Ottawa County (3.5 for every 1,000 children) compared to the state (6.6 for every 1,000 children). Similar results for autism, learning disabilities, and other health impairments are present for 2003 (Table 9).

The rate of autism and learning disabilities in Ottawa County children enrolled in school for 2002 and 2003 is similar to the rates for the State of Oklahoma. The rate of other health impairments in Ottawa County children enrolled in school for 2002 and 2003 is lower than the state rate.

Table 8. School Enrollment of Children with Autism, Learning Disabilities, and Other Health Impairments in Ottawa County and the State; 2002

<i>Category</i>	<i>Statewide Count</i>	<i>Ottawa County Count</i>	<i>Rate Per 1,000 Statewide Enrollment*</i>	<i>Rate Per 1,000 Ottawa County Enrollment**</i>	<i>Is the rate higher in Ottawa County?</i>
Autism	806	7	1.3	1.2	No
Other Health Impaired	4,108	21	6.6	3.5	No
Specific Learning Disability	45,485	444	73.1	73.1	No

*2002 statewide enrollment was 622,139 children

**2002 Ottawa County enrollment was 6,072 children

Table 9. School Enrollment of Children with Autism, Learning Disabilities, and Other Health Impairments in Ottawa County and the State; 2003

<i>Category</i>	<i>Statewide Count</i>	<i>Ottawa County Count</i>	<i>Rate Per 1,000 Statewide Enrollment*</i>	<i>Rate Per 1,000 Ottawa County Enrollment**</i>	<i>Is the rate higher in Ottawa County?</i>
Autism	844	7	1.4	1.2	No
Other Health Impaired	4,816	24	7.7	4	No
Specific Learning Disability	46,417	469	74.4	77.2	Yes

*2003 statewide enrollment was 624,202 children

**2003 Ottawa County enrollment was 6,075 children

Death Rates

ATSDR and OSDH reviewed vital records from the National Center for Health Statistics for U.S. data and the OSDH Center for Health Statistics for the State and Ottawa County data to determine death rates. Because age strongly affects death rate, the death rates for the U.S, Oklahoma, and Ottawa County were adjusted for age.

For the years 1999 to 2003, the age-adjusted death rates for Ottawa County are consistently higher than the rates for Oklahoma; and the rates for Ottawa County and Oklahoma are consistently higher than the U.S. rate (Table 10). For example, in 2003 the age-adjusted death rate in Ottawa County was 1,065 deaths for every 100,000 persons compared to 974 for Oklahoma and 833 for the United States.

Table 10. Age-Adjusted Death Rates; 1999–2003

<i>Year</i>	<i>US</i>	<i>Oklahoma</i>	<i>Ottawa County</i>
1999	875.2	963.3	1045.9
2000	868.3	971.3	1069.7
2001	854.5	964.3	1090.2
2002	845.3	982.9	1006.3
2003	832.7	983.9	1064.5

Department of Mental Health and Substance Abuse Services

In 1999, Oklahoma’s Department of Mental Health and Substance Abuse Services conducted a regional survey to determine the prevalence of serious mental illness for Oklahoma. Data for individual disorders, (i.e., schizophrenia, bipolar disorder) making up the overall category of serious mental illness (SMI) are not available from this survey at the county level. They are, however, available by region. Ottawa County is part of the northeast region, which also includes Delaware, Craig, Mayes, Rogers, Nowata, and Washington Counties. SMI in adults 18 years and older was 3.23% for the northeast region compared to 3.32% for Oklahoma. The occurrence of serious mental illness in the northeast region is similar to Oklahoma.

Strengths and Limitations

This review of health outcome data has drawn from many sources. Its strengths include the analyses of numerous data sources describing morbidity (i.e., disease) and mortality (i.e., death), reliance on robust population-based data sets such as the state’s cancer registry and vital statistics, and the use of multiple geographic areas of analysis. This review also relied on many different datasets describing disease occurrence, death rates, and other community health indicators to evaluate the overall health experience of residents living in Ottawa County and near the Tar Creek Superfund Site. While many of the health outcomes evaluated are not directly associated with the primary contaminants of concern at the site, a broad review of this nature can potentially identify increases in any adverse health conditions that could in turn indicate some unrecognized problems within the community. Many population-based data sets were used in this review, which lends strength to the overall analysis—biases in data collection are typically minimized by using these types of active surveillance programs. The numerous geographic areas of analysis were helpful, given that they enabled investigators to focus on populations living near the site. At the same time, the investigators were not overly influenced by administrative boundaries that often have no relation to environmental exposures or adverse health impacts (e.g. zip code boundaries, county boundaries). A methodological strength used in these analyses is the comparison of overlapping 95% confidence intervals in determining statistical significance for some health outcomes. This method typically overestimates the number of positive correlations and therefore is a conservative approach in comparing the experience of two different populations (Schenker and Gentleman 2001).

On the other hand, some limitations are associated with this type of broad analysis as well, and this is true regardless of geographic extent. These limitations were applicable in this review and included population mobility (i.e., in-migration and out-migration from the area of concern), the inability to link findings at the group level to a potentially impacted individual, and the lack of useful exposure data. Population mobility is a limitation because people who are potentially

exposed to site contaminants may relocate out of the area of analysis and then be diagnosed with a health condition of concern. These individuals will not be included in the health outcome data review even though their condition may be associated with site-specific exposures. Conversely, people may move into the area of analysis and never experience any site-specific exposures but still contribute to diluting any potential increase in adverse health effects (assuming that they do not represent a case of any of the health conditions under review). In-migration and out-migration often make it difficult to quantify the true relationship between site-specific exposures and adverse health effects. The influence of population migration can only be removed by conducting individual level health studies that are much more resource- and time-intensive. The inability to link findings at the group level to any individual is a well-recognized limitation of a general (i.e., ecologic) health outcome data reviews. While this means that findings from a general review are not useful for individual interpretation, much utility remains in these analyses from a public health perspective—they provide a good screening tool for determining if any potential problems exist. Finally, the lack of exposure data for the population of concern further limits these analyses because any increase in adverse health effects cannot be directly associated with site-specific contamination.

Limitations specific to this health outcome data review include the use of telephone survey data (i.e., BRFSS) and the small population in the areas of concern. Because data obtained through the BRFSS included only a small portion of the people who live in Ottawa County, a great deal of variability occurs in the range of prevalence estimates for various outcomes. Census data indicate, however, that telephone usage is prevalent in the area and little difference in telephone usage exists among different racial groups. The 2000 census estimated that more than 90% of all households in Oklahoma had an available telephone. Also, similar, high prevalence usage patterns occurred among racial groups, including American Indians (89.5%), Asian/Pacific Islanders (97.8%), whites (96.3 %) and “other” races (87.9%) in Oklahoma. The percentage of people who smoke in Ottawa County (29%) and the state (25%) is higher than the national average (21%). Smoking is known to be a primary risk factor for many of the conditions evaluated in this report including heart disease, certain cancers, stroke, and lung disease.

Community Health Concerns

As a follow-up to LEAD Agency’s 2003 community survey of diseases, representatives from LEAD Agency expressed concern about the high number of people in the Tar Creek area with asthma, obesity, cancer, hypertension, and other health outcomes.

In response to these concerns, ATSDR and OSDH reviewed health outcome data for Ottawa County and the Tar Creek area, looking at all health outcomes where data were readily available.

The results of this analysis are presented in the Discussion section of this public health assessment and a summary is provided in the Conclusions section.

Response to Public Comments

On November 21, 2006, ATSDR released this public health assessment for public comment. After a 60 day comment period, the agency received 13 comments from the public. The comments and ATSDR’s response are presented in Appendix C.

Conclusions

As a follow up to a community health survey released by Local Environmental Action Demanded (LEAD) Agency, Inc., OSDH and ATSDR have reviewed the rate of occurrence for selected health outcomes in the Tar Creek Superfund area, in Ottawa County, and in the northeast region of Oklahoma. Health outcome rates were compared to state rates and occasionally to national rates.

Using results from a telephone survey of adults, the occurrence of asthma, arthritis, coronary heart disease, high blood pressure (hypertension), myocardial infarction (heart attack), stroke, high cholesterol, osteoporosis, diabetes, high blood pressure, serious mental illness, smoking, and obesity in Ottawa County adults is similar to the state rates for those conditions.

OSDH and ATSDR also evaluated several health outcomes associated with pregnancies, newborns, and children. The rate of low-birth weight babies and preterm babies is slightly lower in Ottawa County compared to the state rates, while the occurrence of hearing loss in newborn infants in Ottawa County is similar to the national rate. The occurrence of birth defects in Ottawa County varies from 1994 to 2002, probably because of the county's small population. From 1994 to 2000, the occurrence of birth defects in Ottawa County was lower than in the state; while for the years 2001 and 2002, the occurrence of birth defects in Ottawa County was slightly higher than in the state. As mentioned, the variation in birth defects rates during these years is probably due either to chance variation or to the small population in the county. The occurrence of autism and learning disabilities in children from Ottawa County is similar to state rates.

Data are not available for mental illness in Ottawa County but are available for the seven counties that make up the northeast region of Oklahoma. The occurrence of serious mental illness in the northeast region of Oklahoma is similar to the state experience.

OSDH and ATSDR also evaluated death rates from certain diseases reported to the state's vital records from 1999 to 2003. The age-adjusted death rate in Ottawa County is similar to the state's death rate for high blood pressure, liver disease, diabetes, and atherosclerosis. The age-adjusted death rate in Ottawa County from Alzheimer's disease and from kidney disease is lower than the state death rate from these diseases. The death rate from heart disease in Ottawa County is higher than the death rate for the state (248 versus 225 for every 100,000 persons). The slightly higher death rate for heart disease in Ottawa County could be due to chance variation.

The overall death rate in Ottawa County is higher than in the state (1,069 versus 977 for every 100,000 persons), while Ottawa County's and the state's death rates are higher than the national average (855 for every 100,000 persons). The leading causes of death in Oklahoma are heart disease, cancer, stroke, lung disease, and injury.

It should be noted that the percentage of Ottawa County residents who smoke (29%) and the state (25%) are both higher than the national average (21%). Smoking is known to increase heart disease, certain cancers, stroke, and lung disease.

For the top 10 cancer types, cancer incidence in Ottawa County and in the five zip code area surrounding the Tar Creek Superfund Site is similar to cancer incidence in the state.

In summary, data on the occurrence of numerous health outcomes for Ottawa County show the occurrence of most diseases and health conditions to be similar to occurrences in the entire state. Statistical tests indicated that, for almost all circumstances, none of these rates were truly

different from rates in the state. One possible reason for this conclusion is that the small number of people who live in Ottawa County makes difficult verification of any true differences.

Recommendations

OSDH and ATSDR recommend

- State and federal health agencies hold public meetings to present the findings of their health outcome data analysis. These meeting were held in November 2006 with the release of the public comment version of this public health assessment.
- State and federal health agencies meet with the Ottawa County Health Department to discuss the results of this public health assessment and to determine if any additional health education activities are warranted. These meetings took place shortly after the release of the public comment version of this public health assessment.
- ATSDR evaluate the feasibility of conducting a health outcome data review focused on American Indians who live in and around the Tar Creek Superfund Site.

Public Health Action Plan

OSDH and ATSDR met with the Ottawa County Health Department to discuss the results of this public health assessment and to determine if any health education activities are warranted.

ATSDR will hold discussions with staff members from the Indian Health Service, from American Indian tribes in the area, from the Oklahoma Area Epidemiology Program, from LEAD Agency, and from OSDH to evaluate the feasibility of a health outcome data review focused on American Indians who live in and around the Tar Creek Superfund Site.

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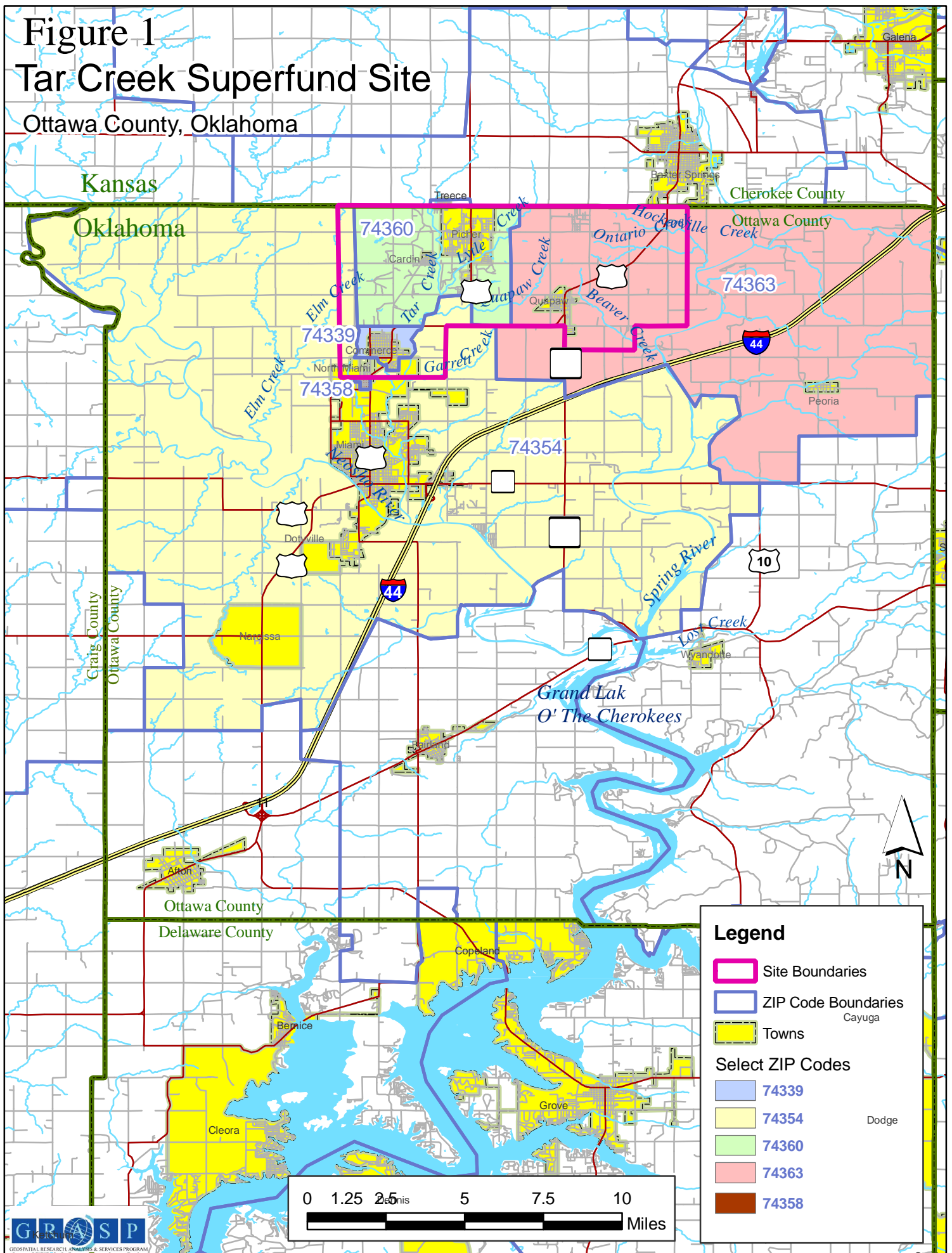
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Appendix A. Figure 1, Map showing five zip codes nearest the Tar Creek Superfund Site

Figure 1 Tar Creek Superfund Site

Ottawa County, Oklahoma



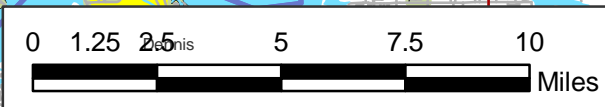
Legend

- Site Boundaries
- ZIP Code Boundaries
- Towns

Select ZIP Codes

- 74339
- 74354
- 74360
- 74363
- 74358

Cayuga
Dodge



Appendix B. Literature Review: Frequency and Cause of Early Pregnancy Loss

LEAD Agency, a local environmental action group involved with public health issues surrounding the Tar Creek Superfund Site, requested that ATSDR and OSDH provide a summary of the current literature concerning miscarriages.

Frequency

The terms *spontaneous abortion* and *miscarriage* are traditionally used to refer to pregnancy loss prior to 20 weeks gestation. Of all clinically documented pregnancies, 10%–15% end in miscarriage by the 12th–14th week of gestation (Fausett and Branch 2002; Cappola and Coppola 2003). The actual rate of early pregnancy loss is most likely two to three times higher because many early pregnancy losses occur before the next expected menstrual cycle and are not recognized.

Cause

Miscarriages can be classified as single, sporadic, or repetitive. Most single or sporadic miscarriages are caused by chromosomal errors in the developing conceptus, defective implantation, defects in the developing embryo or placenta, or unknown causes. Approximately one-third of miscarriages occurring before 9 weeks gestation are anembryonic (empty gestational sac). During the first trimester, 60% of fetuses with chromosomal abnormalities are miscarried (Branch and Scott 2003). In 40%-50% of women experiencing a miscarriage, the cause remains unknown (Kalro 2003).

Half of all miscarriages are caused by chromosomal abnormalities of the developing fetus (Cappola and Coppola 2003). Additional factors implicated in early pregnancy loss include increasing maternal age, smoking, endocrine dysfunction, autoimmune disorders, environmental toxins, alcohol, drugs, chronic maternal diseases, genital tract abnormalities, and a history of three or more miscarriages.

The association of advanced maternal age and escalating rates of pregnancy loss are well documented. Miscarriage rates increase to 34%–53% in women over 40–45 years old compared with the 15% chance of miscarriage in women less than 35 years old (Pal and Santoro 2003). Several factors influence these rates:

Females

Declining oocyte (i.e., egg) quality with increasing chromosomal and genetic mutations, and Implantation failures resulting from poor quality embryos, impaired endometrial receptivity, and a higher incidence of age related gynecological problems including uterine fibroids and polyps.

Males

Decline in semen number, motility, and morphology,
Higher incidence of chromosomal aberrations in sperm, and
Possible declining fertilization potential of sperm.

The effects of smoking on developing oocytes are well documented. Some research also supports the association between smoking and an increased risk of aneuploidy (abnormal number of

chromosomes) in the developing embryo (Pal and Santoro 2003). Epidemiologic studies have linked early miscarriage with smoking, including second-hand smoke (Silbergeld and Patrick 2005).

Recurrent miscarriage is defined as two or three consecutive first trimester spontaneous losses (Branch and Scott 2003). Between 10% and 23% of repetitive pregnancy losses are attributed to endocrine dysfunction. This can include thyroid dysfunction, the presence of antithyroid antibodies, diabetes, adrenal disorders, Cushing's Syndrome, and more. These disorders affect circulating available levels of hormones necessary to stimulate ovulation and maintain a viable pregnancy. Low levels of circulating hormones, especially progesterone, cause endometrial dysfunction. This causes an environment unfavorable to implantation and the developing embryo. Returning women to a normal thyroid state greatly increases the chances of improved outcomes with subsequent pregnancies. Several studies have demonstrated an association between the presence of antithyroid antibodies and recurrent first trimester pregnancy loss. Thyroid antibodies can coexist with other autoantibodies, which may suggest an underlying immunoregulatory effect (Kalro 2003).

Preconception counseling is critical in diabetic women to reduce the risk of miscarriage, fetal abnormalities, and other pregnancy complications (Kalro 2003, Galerneau and Silvio 2004). Increased rates of spontaneous miscarriage have been demonstrated in numerous studies of patients with both Type 1 and Type 2 diabetes. When glycemic control is achieved prenatally, the risk of obstetric complications decreases significantly. Women with preexisting diabetes are also at risk for magnesium deficiency through increased renal loss, which may be associated with early pregnancy loss.

Autoimmune disorders play a major role in recurrent pregnancy loss. Systemic lupus erythematosus, antiphospholipid syndrome (APS), and antithyroid antibodies have been associated with adverse fetal outcomes for almost 30 years. These disorders are associated with a higher risk of fetal loss after 10 weeks gestation (Fausett and Branch 2002). Insufficient blood flow to the placenta resulting from thrombotic events leads to loss of pregnancy.

Environmental toxins have also been implicated as causal factors in the incidence of spontaneous miscarriages. Environmental hazards can include lead, air pollution, agrochemicals, incinerator emissions, and releases from hazardous waste sites. The Centers for Disease Control and Prevention's National Center for Environmental Health recently assessed women of childbearing age and their exposure to environmental toxins. These surveys revealed women continue to be exposed to major reproductive toxicants including lead, organochlorine insecticides, methyl mercury, cigarette smoke, organophosphate pesticides, and certain organic solvents (Silbergeld and Patrick 2005).

In 1911, Sir Thomas Oliver noted "pregnancy seems to make lead poisoning worse" (Silbergeld and Patrick 2005). Mobilization of stored lead from the bone into the circulatory system increases during pregnancy. Current studies have found that bone-lead stores may contribute as much as 33% to maternal blood levels during pregnancy and that maternal-fetal blood levels are nearly equivalent (Silbergeld and Patrick 2005). Studies have also shown an association between paternal exposure to environmental toxins and adverse developmental outcomes in children who survive (Silbergeld and Patrick 2005).

Low levels of progesterone have long been implicated as a cause of early miscarriage also. The corpus luteum produces progesterone until approximately 8 weeks when the developing trophoblast takes over as the major source of progesterone. Single measurements of progesterone have been used to distinguish normal pregnancies from nonviable or ectopic ones. This test is useful if the progesterone levels fall below 5 ng/mL (nonviable) or above 25 ng/mL (viable). Since most patients' levels fall in between 10 and 20 ng/mL, this test is usually only used as an adjunct to hCG levels and ultrasonography (Oral and Genc 2004). Progesterone supplementation can be provided through the first trimester for women with low progesterone levels.

Structural uterine defects including septate uterus, other mullerian anomalies, uterine defects associated with diethylstilbestrol exposure, submucous myomas, intrauterine synechiae, and bicornate uterus have long been associated with recurrent early pregnancy loss. The cause of pregnancy loss in these women is uncertain. Possible causes include diminished blood supply interfering with normal implantation and placental development, and the reduced size of the uterine cavity. However, these explanations appear unlikely in some situations (Branch and Scott 2003).

The causes of spontaneous pregnancy loss include a myriad of embryonic, hormonal, endocrine, anatomic, autoimmune, chromosomal, and environmental possibilities. Most researchers agree that chromosomal abnormalities account for the majority of spontaneous miscarriages. Physicians and researchers are working diligently to determine the relationship of all other causal factors implicated in spontaneous termination of pregnancy before the period of viability.

Appendix C: Response to Public Comments

On November 21, 2006, ATSDR released this public health assessment for public comment. After the 60 day comment period, the agency received 13 comments from the public. The comments and ATSDR's response follow.

1. More information is needed about contamination of the Grand Lake, including samples of lake sediment and cleanup of flood areas along the lake.

ATSDR/OSDH Response: This question has also been raised by LEAD Agency and other members of the Tar Creek health team. ATSDR/OSDH and the Tar Creek health team recommended to OK DEQ that they include fish collected from the Grand Lake as part of their 2007 fish collection study. The OK DEQ agreed to collect fish from the Grand Lake as well as the Neosho and Spring Rivers, which were previously sampled in 2002.

At this time, ATSDR/OSDH is unaware of any plans by other agencies to sample sediment from the Grand Lake. Should fish from the lake contain harmful levels of metals, sampling of lake sediment might be possible.

2. A resident has health concerns about a mushroom farm in Ottawa County, J & M Mushroom Farm. The resident is concerned about allergies, asthma, headaches, and lung problems. The resident states that an odor comes from the mushroom farm, particularly in the evening.

ATSDR/OSDH Response: This concern was also raised by LEAD Agency during a meeting with ATSDR/OSDH staff members in November 2006. The OK State Department of Health was also in attendance and agreed to look into this matter, including residents concerns about odor and health issues. OSDH disease surveillance systems lack information for the conditions listed above to further determine whether the prevalence of these conditions is occurring more frequently than expected in Miami, Oklahoma. As an agricultural industry, the Oklahoma State Department of Agriculture has regulatory authority over this farming operation. The Department of Agriculture reported that J&M Mushroom Farms, Inc. was in compliance with state regulations. Since this concern is not related to air emissions, this issue does not fall under the regulatory authority of the Air Quality Division, Oklahoma Department of Environmental Quality (ODEQ).

3. A resident stated it is essential that more detailed health studies be conducted for the Tar Creek Superfund area.

ATSDR/OSDH Response: As part of ATSDR/OSDH's follow-up to the "Public Health Assessment, Occurrence of Selected Health Conditions in Ottawa County, Oklahoma," ATSDR and OSDH will have discussions with LEAD Agency, American Indian tribes in the area, and other federal, state, and local agencies, to

discuss the usefulness of conducting a more specific health investigation regarding residents living close to the Tar Creek site. These discussions will take place in 2008.

4. A resident would like to know if there is a relationship between community awareness of environmental problems and lower prevalence of health problems.

ATSDR/OSDH Response: Studies show that health education efforts in a community dealing with environmental contamination will result in lower exposure to environmental contaminants in residents because people consciously and subconsciously change behaviors that reduce contact with contaminated media. It is reasonable to assume that lower exposure to lead in children because of health education efforts over the last 10 years will have a positive impact on measurements of IQ, hearing, and learning disabilities in children. The degree to which health education efforts might affect the rates of other conditions reported in the public health assessment is unknown.

5. A resident stated that ATSDR/OSDH's public health assessment showed similar health status in residents of Ottawa County compared to the rest of the state. The resident asked if this meant that the environmental contaminants do not actually cause detrimental health effects in the rates reported in the public health assessment, or if it meant that Ottawa County [and other agencies'] efforts are having a positive impact on disease rates.

ATSDR/OSDH Response: ATSDR/OSDH cannot determine a cause and effect relationship from the data collected and the rates that are presented in the public health assessment about specific health outcomes. The results presented in this public health assessment cannot be used to determine whether contamination from the Tar Creek Superfund site directly contributes to disease and death in Ottawa County. The rates of various diseases and deaths are an indicator of the overall health experience of residents in Ottawa County compared to residents of the state of Oklahoma. Any further conclusions about these rates being related to the Tar Creek Superfund site are not possible.

6. Is the percent of illnesses in the quadrants identified in the LEAD Agency survey due to location, that is, due to proximity to the mine site and Tar Creek?

ATSDR/OSDH Response: ATSDR/OSDH cannot answer this question from the data that were analyzed nor can we imply causation based on prevalence data in the LEAD report. ATSDR/OSDH is not able to determine that the percent of illnesses in the quadrants identified in the LEAD Agency survey are due to proximity to the mine site and Tar Creek.

7. The telephone survey does not necessarily reflect the LEAD Agency's study area, which includes more detailed results in focused areas. The other data sets are only as good as the reporting and may miss many people who live in the area surveyed by LEAD Agency.

ATSDR/OSDH Response: ATSDR/OSDH agrees. This issue is addressed in the limitations section of this public health assessment. The Behavioral Risk Factor Surveillance System (BRFSS) provides population-based health information on health conditions and risk factors. The BRFSS data presented in the public health assessment are a population sample of Ottawa County residents. A different study is required to determine whether or not the percent of illnesses in the quadrants identified in the LEAD Agency survey are due to proximity to the mine site and Tar Creek.

8. The large geographic area encompassed by the county might mask effects in smaller geographic units within the county that have higher exposure to metals. For example, children and adults in Picher might experience greater rates of learning disabilities and other health conditions compared to other parts of the county with lower exposure to metals.

ATSDR/OSDH Response: ATSDR/OSDH agrees. The limitations of reporting county wide rates are addressed in this public health assessment. In addition, we are having discussions about the feasibility of doing a more focused evaluation.

9. The statement, "the overall health experience of residents in Ottawa County is similar to the state of Oklahoma" is misleading because of the limitations of the county-wide data used in the public health assessment and the LEAD Agency survey.

ATSDR/OSDH Response: Our evaluation of health outcome experiences for residents of Ottawa County shows that as a county the residents have similar health experiences as residents of the state of Oklahoma except for mortality from cardiovascular disease. We think the question actually focuses on the lack of more specific data on some residents, that is, the inability to look at smaller geographic units or to look at health outcome data using exposure to contaminants from the Tar Creek Superfund Site. For this reason, we recommended in the PHA to have discussions with LEAD Agency and American Indian tribes in the area to discuss the feasibility of doing a more focused evaluation.

10. There is concern that the results of the public health assessment will hamper remedial activities necessary to clean up the Tar Creek Superfund site.

ATSDR/OSDH Response: The remedial efforts are based on contaminant levels in soil, chat piles, and other media and clean up levels are determined by EPA's risk assessment process. The findings in this public health assessment should not be used to decide clean-up activities because we were limited to county-wide data when evaluating health outcomes.

11. ATSDR/OSDH's recommendation to study American Indians in the Tar Creek Superfund area will not answer the question about whether residents in the Tar Creek area might be experiencing health effects from exposure to metals compared to other residents in Ottawa County.

ATSDR/OSDH Response: ATSDR recommends having discussions with the Indian Health Service, LEAD Agency, and American Indian tribes in the area to evaluate the feasibility of conducting a health outcome data review focused on American Indians who live in and around the Tar Creek Superfund Site. At this time, we are only discussing the feasibility of additional studies to determine if useful public health information can be obtained to guide public health activities at the site. This activity was suggested after talking with American Indian tribes in the area and LEAD Agency representatives. No decisions have been made about whether a study is feasible. We agree, though, that a study focused only on American Indians has limited application to other racial, cultural, and ethnic groups that live in the Tar Creek area.

12. LEAD Agency recommends that ATSDR/OSDH conduct a door-to-door survey to address questions about increased rates identified in the LEAD Agency survey.

ATSDR/OSDH Response: ATSDR/OSDH recommended in the PHA to have discussions with LEAD Agency and American Indian tribes in the area to discuss the feasibility of doing a more focused evaluation. Many things have to be considered when deciding what health study activities are appropriate for a more focused investigation. ATSDR and OSDH are discussing some of these options and will have discussions with LEAD Agency and American Indian tribes in the area as a follow-up activity.

13. LEAD Agency suggests that a study of American Indians might provide useful information about exposure pathways that might be occurring at the Grand Lake.

ATSDR/OSDH Response: ATSDR recommends having discussions with the Indian Health Service, LEAD Agency and American Indian tribes in the area to evaluate the feasibility of conducting a health outcome data review focused on American Indians who live in and around the Tar Creek Superfund Site.

Additional environmental information is being collected that might be useful in addressing this issue. Information about contaminant levels in fish in the Grand Lake is now available from the Oklahoma Department of Environmental Quality. EPA and other groups are collecting environmental samples from the Spring and Neosho Rivers, which will help determine the possibility of metals reaching Grand Lake. ATSDR is working with American Indian tribes in the area to evaluate native foods. As these data become available, discussions can take place between federal and state agencies, American Indian tribes, and LEAD Agency about the usefulness of a study of American Indians.