The Burden of Asthma in Kansas

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KANSAS ENVIRONMENTAL PUBLIC HEALTH TRACKING

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Our Vision – Healthy Kansans living in safe and sustainable environments.

Our Missions – To protect and improve the health and environment of all Kansans.

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Executive Summary

The impact of asthma ranges from missed school and work to emergency department visits, hospitalizations, and even death. Asthma has affected about 1 in 8 adults in Kansas during their lifetime. It is also a burden to the quality of life of Kansans of all ages. This report describes the characteristics of those with asthma and evaluates various impacts of the disease, including health care use and mortality.

- Adult females in Kansas had a higher prevalence of current asthma than males (11.5% and 6.7%, respectively), but male children in Kansas had a higher prevalence of current asthma than females (11.1% and 6.7%, respectively).
- Adults from lower-income households had a higher prevalence of current asthma than those from higher income households.
- Adults that were college graduates had a lower prevalence of current asthma than those that had less than a high school education (7.4% and 11.8%, respectively).
- Adult Kansans that reported being more than one race or reported their race as black or African American had a statistically significantly higher prevalence of current asthma compared to those that reported their race as white (17.3%, 12.3%, and 8.9%, respectively).
- Black or African American, American Indian or Alaska Native, and multi-racial children in Kansas had a higher estimated prevalence of current asthma compared to white children (14.3%, 15.0%, 12.5%, and 8.3%, respectively).
- Current smokers and those with obesity have a statistically significantly higher prevalence of current asthma compared to non-smokers and those that are not obese.
- About one-fourth of adults and over half of children with current asthma had received an asthma action plan from a physician.
- Children 0-4 years old had the highest rate of ED visits and hospitalizations for asthma compared to all other age groups.
- Kansans that are black or African American, and those that are not black or African American or white, had statistically significantly higher rates of ED visits and hospitalizations for asthma compared to those that are white.
- The number of deaths due to asthma has risen slightly in the US and Kansas over the 2010-2017 period.
- Among Medicaid recipients, females age 35-64 had the highest prevalence of persistent asthma compared to males and other age groups.

Introduction

Asthma is a chronic disease that can make breathing difficult. Persons with asthma can experience episodes of breathlessness, wheezing, coughing, chest tightness, and other symptoms when their airflow is limited (1). Asthma makes breathing difficult because of airway inflammation (2). However, the causes of this inflammation are not known (2). When the airways become inflamed, contraction of airway muscles, excessive mucus production, and swelling of the airways contribute to breathing difficulties and other asthma symptoms (2). An asthma attack can occur when air passages in the lungs become narrower after an exposure to a trigger (2).

Asthma episodes can range from intermittent to persistent-severe. The severity classification depends on several factors including the frequency of symptoms, nighttime awakenings, use of short-acting inhalers for symptom control, interference with normal activity, lung function, and episodes that require oral medication (3). Initial therapy for asthma is determined by the severity classification (3). Asthma can be severe enough that it causes missed days of work and school, emergency department (ED) visits, hospitalizations, and even death.

Asthma affects both children and adults. Asthma in the United States has increased and is one of the most common chronic diseases. In 2016 in the United States, 13.7% of adults age 18 years and older reported having asthma in their lifetime and 12.5% of children under the age 18 years had asthma (4,5). In Kansas, these numbers were similar at 13.1% and 12.3%, respectively (4,5). Asthma is a burden to an individual's quality of life, as well as an economic burden. This report summarizes data on asthma prevalence and burden in Kansas and includes data from 2000 to 2017.

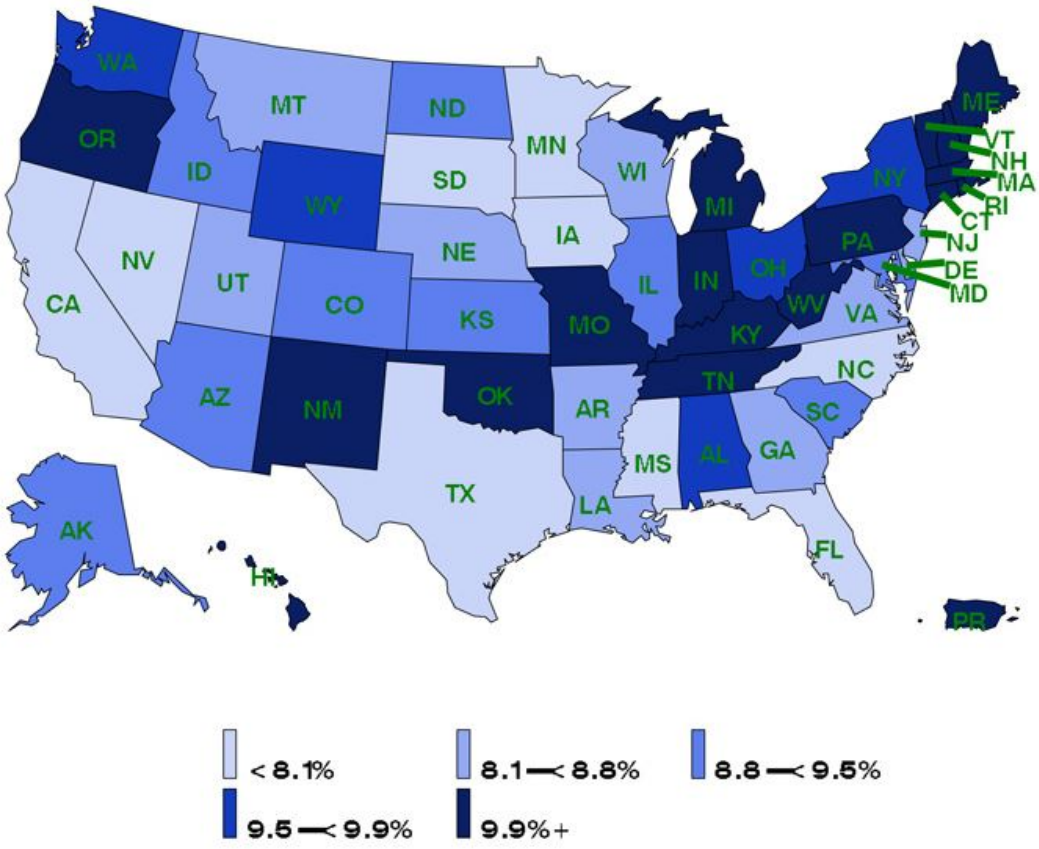
Asthma Prevalence

The prevalence of asthma is the percentage of the population with asthma during a specific period. The Kansas Behavioral Risk Factor Surveillance System (BRFSS) data was used to estimate the prevalence of asthma in Kansas for adults and children and the national BRFSS program data for each state are presented for comparison (6, Appendix A). Asthma prevalence can be measured by lifetime asthma and current asthma. Lifetime asthma is when an individual has ever been told by a healthcare professional that they have asthma, this individual may or may not still have asthma. Current asthma is when an individual has ever been told by a healthcare professional that they have asthma and they still have asthma at the time that they were surveyed.

Prevalence of Adults with Asthma

Using 2016 BRFSS data, compared to other states, the percentage of adult Kansans with current asthma was average (Map 1). Compared to neighboring states, Kansas had a lower prevalence of asthma than Missouri and Oklahoma, but had a higher prevalence than Nebraska.

Map 1. Current Asthma Prevalence in Adults Age 18 Years and Older by State, United States 2016

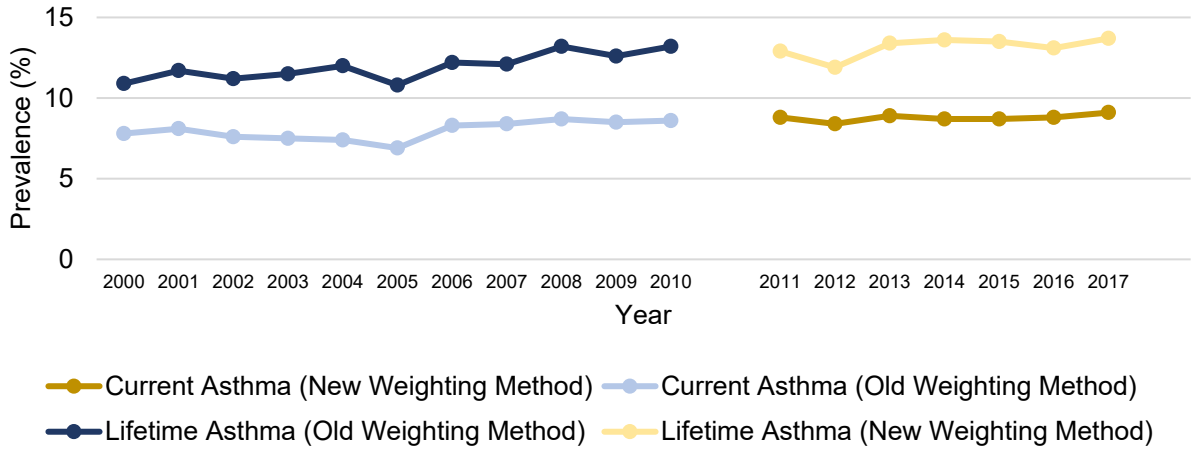


Source: Centers for Disease Control and Prevention, Behavioral Risk Factor Surveillance System and map created by the National Center for Environmental Health Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/asthma/brfss/2016/mapC1.htm.

Adult and child lifetime and current asthma prevalence are estimated using Kansas BRFSS data. Because there were different weighting methodologies used for BRFSS data collected before 2011, data from 2010 and earlier should not be directly compared to data from 2011 and after. Differences observed may be due to the difference in methodology rather than an actual difference in prevalence.

The lifetime prevalence of asthma in adult Kansans appears to have a slight upward trend since 2011 (Figure 1). The current asthma prevalence appears to have little variation in its estimate since 2006. In 2005, the estimated lifetime and current asthma prevalence for adults in Kansas was the lowest for this 17-year span at 10.8% (CI: 9.9%-11.6%) and 6.9% (CI: 6.3%-7.6%), respectively. The estimated lifetime and current asthma for adult Kansans was highest in 2017 at 13.7% (CI: 13.1%-14.3%) and 9.1% (CI: 8.6%-9.6%), respectively. The trend of both lifetime and current asthma prevalence has not significantly changed from 2011 to 2017.

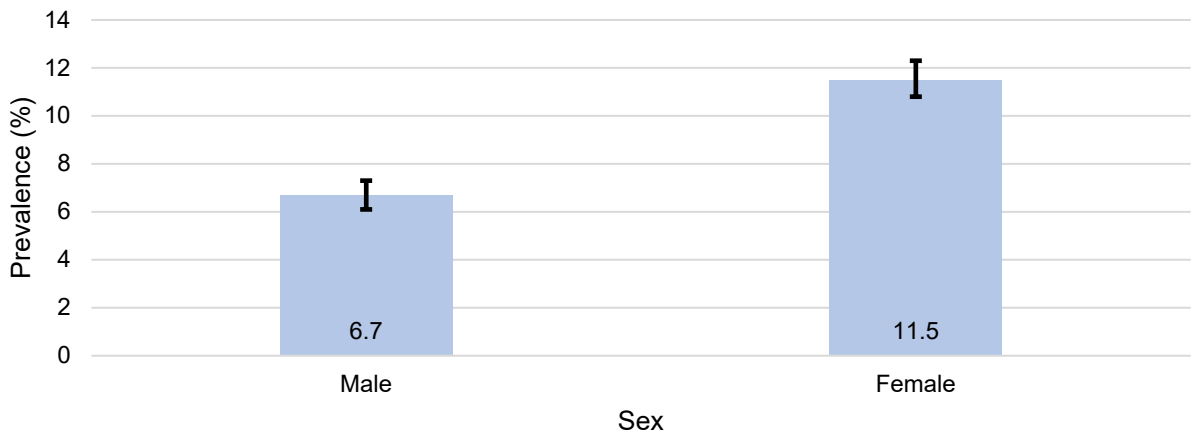
Figure 1. Lifetime and Current Asthma Prevelance in Adults Age 18 Years and Older, Kansas 2000-2017*



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.
*Note: BRFSS weighting methodology is different for data after 2010; therefore, BRFSS data from 2010 and earlier cannot be directly compared to BRFSS data from 2011 and after. The difference observed may be due to the difference in methodology and not an actual difference in prevalence.

Nationally, adult women tend to have a higher prevalence of asthma than men (7,8). Among adult females in Kansas, 11.5% (CI: 10.8%-12.3%) had asthma in 2017 (Figure 2). Male adults in Kansas had a prevalence of only 6.7% (CI: 6.1%-7.3%) in 2017. The difference in prevalence between males and females was statistically significant.

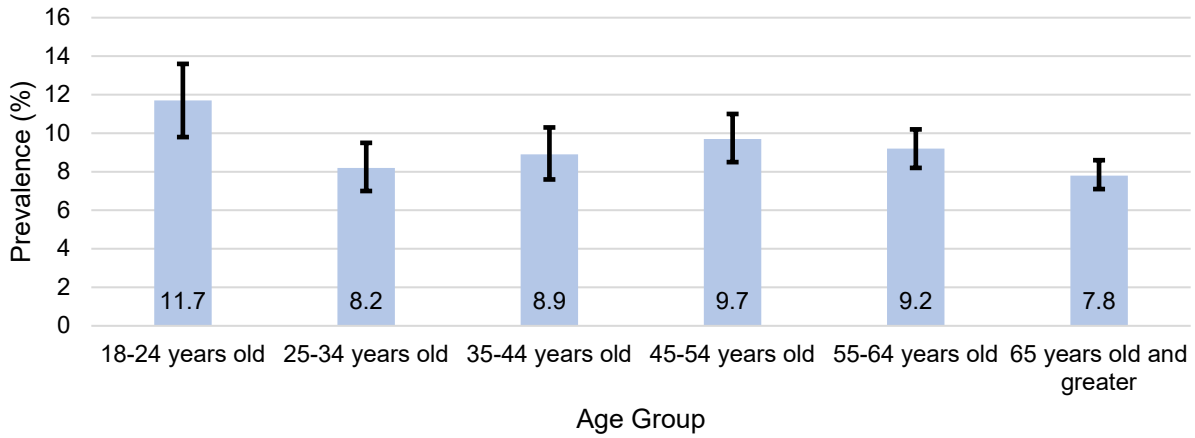
Figure 2. Prevalence of Current Asthma Among Adults Age 18 Years and Older by Sex, Kansas 2017



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Although common among all ages, asthma, particularly severe asthma, is observed more often in young boys and middle-aged women (9). Among adults in Kansas, the 18-24 years old age group had the highest prevalence of current asthma in 2017 at 11.7% (CI: 9.8%-13.6%) (Figure 3). The 65 years old and greater age groups had the lowest prevalence of current asthma at 7.8% (CI: 7.1%-8.6%). The difference in current asthma prevalence among adults age 18-24 years was statistically significantly higher than the 25-34 years (8.2%, CI: 7.0%-9.5%) and 65 years and greater age groups.

Figure 3. Prevalence of Current Asthma Among Adults Age 18 Years and Older by Age Group, Kansas 2017

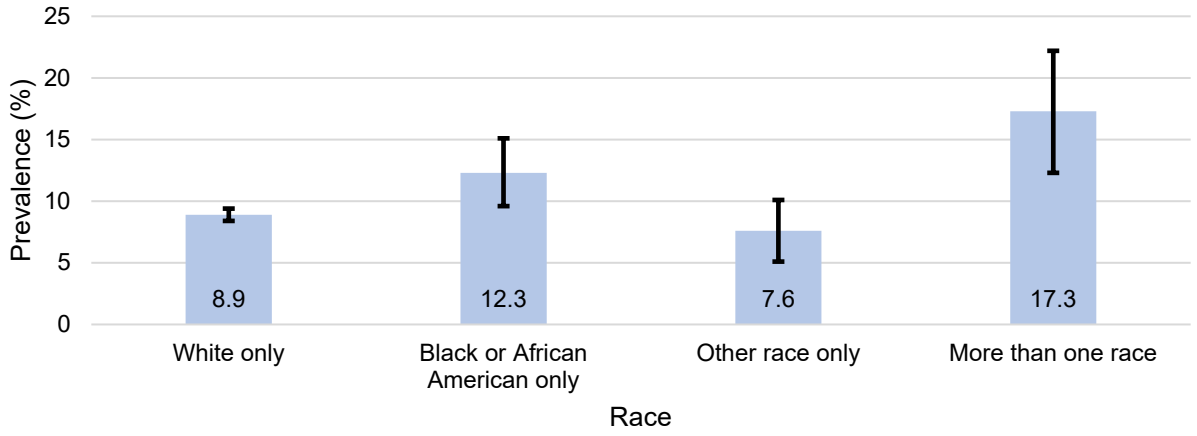


Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Nationally, asthma prevalence is higher among those that are multi-racial, black or African American, and American Indian or Alaska Native than those that are white (8). Among adults in Kansas, those that self-identified as more than one race had the highest prevalence of current

asthma in 2017 at 17.3% (CI: 12.3%-22.2%) (Figure 4). Those that identified as a race other than white, black or African American, or multi-racial had the lowest prevalence of current asthma at 7.6% (CI: 5.1%-10.1%). The current asthma prevalence for white respondents (8.9%, CI: 8.4%-9.4%) was statistically significantly lower than those that self-identified as black or African American only (12.3%, CI: 9.6%-15.5%) and those that identified as more than one race.

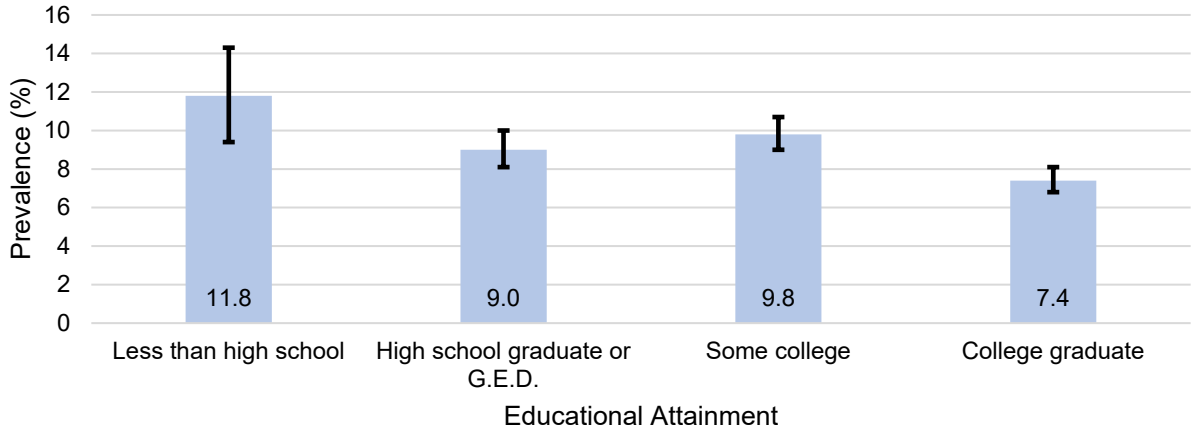
Figure 4. Prevalence of Current Asthma Among Adults Age 18 Years and Older by Race, Kansas 2017



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Links between poverty and asthma and mother's level of education and childhood asthma have been reported in some literature (8, 10). Among adults in Kansas, those reporting less than a high school education had the highest prevalence of current asthma at 11.8% (CI: 9.4%-14.3%) (Figure 5). Those that were college graduates had the lowest prevalence of current asthma at 7.4% (CI: 6.8%-8.1%). The difference in current asthma prevalence was statistically significantly lower in college graduates compared to those that had less than a high school education and those that had some college education.

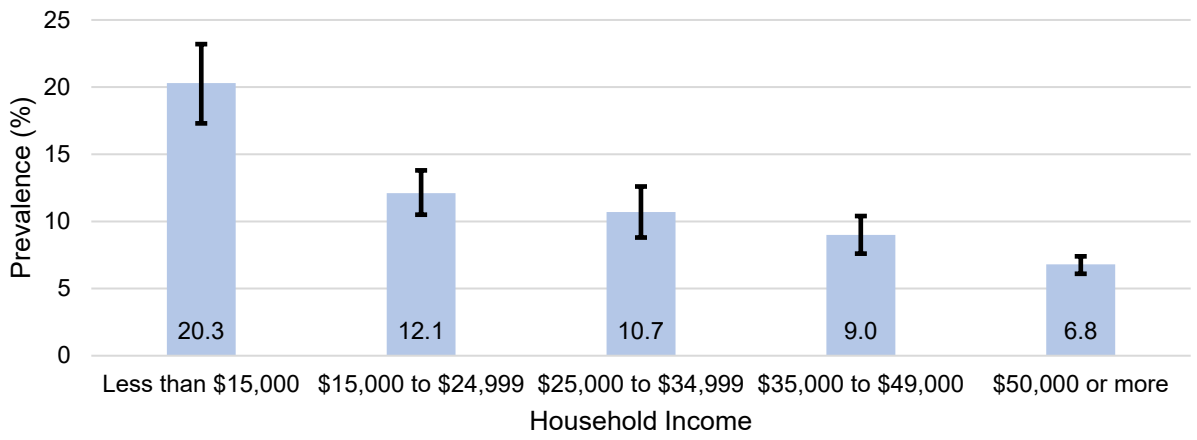
Figure 5. Prevalence of Current Asthma Among Adults Age 18 Years and Older by Educational Attainment, Kansas 2017



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from http://www.kdheks.gov/brfss/index.html.

Asthma affects those that are economically disadvantaged at a disproportionately higher frequency than those that are not economically disadvantaged (11). Among adults in Kansas, those that had an annual household income of less than $15,000 had the highest prevalence of current asthma in 2017 at 20.3% (CI: 17.3%-23.2%) (Figure 6). Those that had an annual household income of $50,000 or more had the lowest prevalence of current asthma at 6.8% (CI: 6.1%-7.4%). In general, the prevalence of asthma appears to decrease as household income increases, though not all differences were statistically significant. The prevalence of current asthma in households with an annual household income of less than $15,000 was statistically significantly higher than all other income groups. The prevalence in households with an annual household income between $15,000 and $24,999 was statistically significantly higher than the two highest income groups (12.1%, CI: 10.5%-13.8%). The prevalence in households with an annual household income of $50,000 or more was statistically significantly lower than all other income groups.

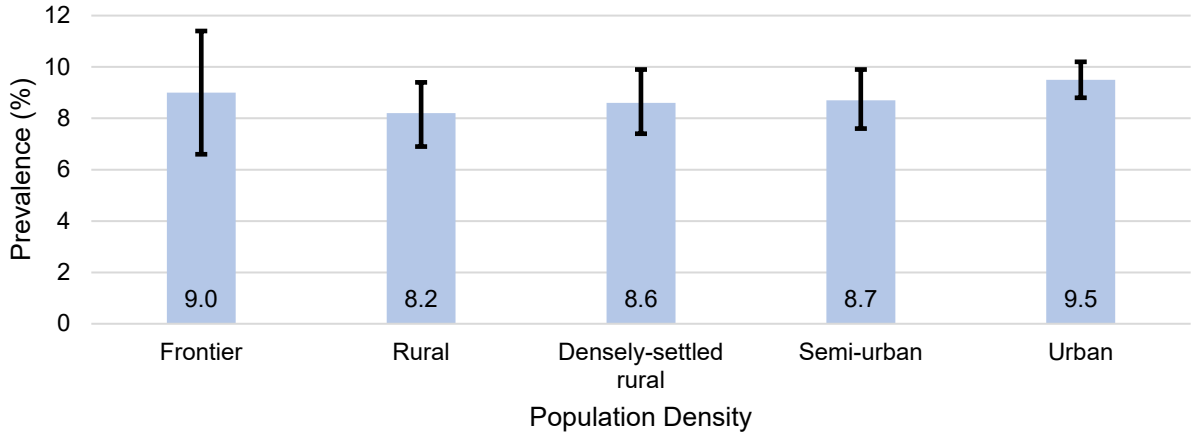
Figure 6. Prevalence of Current Asthma Among Adults Age 18 Years and Older by Household Income, Kansas 2017



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Several studies have suggested that those living in an urban setting are exposed to environmental risk factors for asthma at a greater frequency than those living in a rural setting (12). Determining any difference in asthma prevalence associated with population density is important to help identify the burden of asthma based on where people live and develop any interventions to reduce morbidity and mortality. Among adults in Kansas, those that live in an urban area had the highest prevalence of current asthma in 2017 at 9.5% (CI: 8.8%-10.2%) (Figure 7). Those that live in a rural area had the lowest prevalence of current asthma at 8.2% (CI: 6.9%-9.4%). The difference in current asthma prevalence was not statistically significantly different between these different population densities.

Figure 7. Prevalence of Current Asthma Among Adults Age 18 Years and Older by Population Density*, Kansas 2017



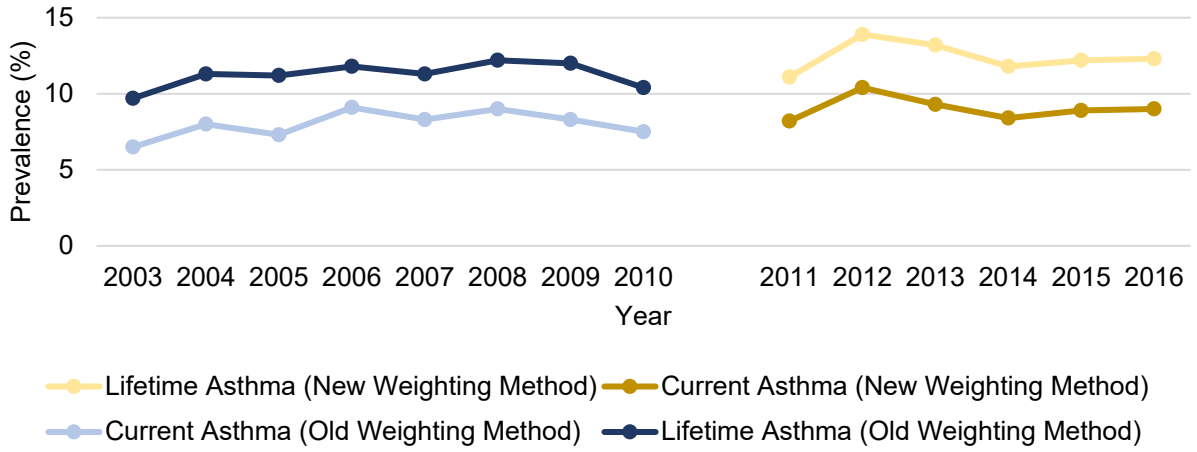
Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

*Population density categories are defined by county using the following definitions: Frontier – less than 6 persons per square mile (36 Kansas counties); Rural – 6 to less than 20 persons per square mile (33 Kansas counties); Densely-settled rural – 20 to less than 40 persons per square mile (20 Kansas counties); Semi-urban – 40 to less than 150 persons per square mile (10 Kansas counties); Urban – 150+ persons per square mile (6 Kansas counties) (13).

Prevalence of Asthma in Children

Since 2003, the lifetime and current asthma prevalence in Kansas children have gone up and down, but overall appear to have increased slightly. The lifetime and current asthma prevalence of children were both at their highest in 2012 at 13.9% (CI: 12.3%-15.5%) and 10.4% (CI: 9.0%-11.9%), respectively, and appear to have decreased slightly since then (Figure 8). The lifetime and current asthma prevalence of children were both at their lowest in 2003 at 9.7% (CI: 8.0%-11.5%) and 6.5% (CI: 5.1%-7.9%), respectively. The trend of both lifetime and current asthma prevalence of children in Kansas has not significantly changed from 2011 to 2016.

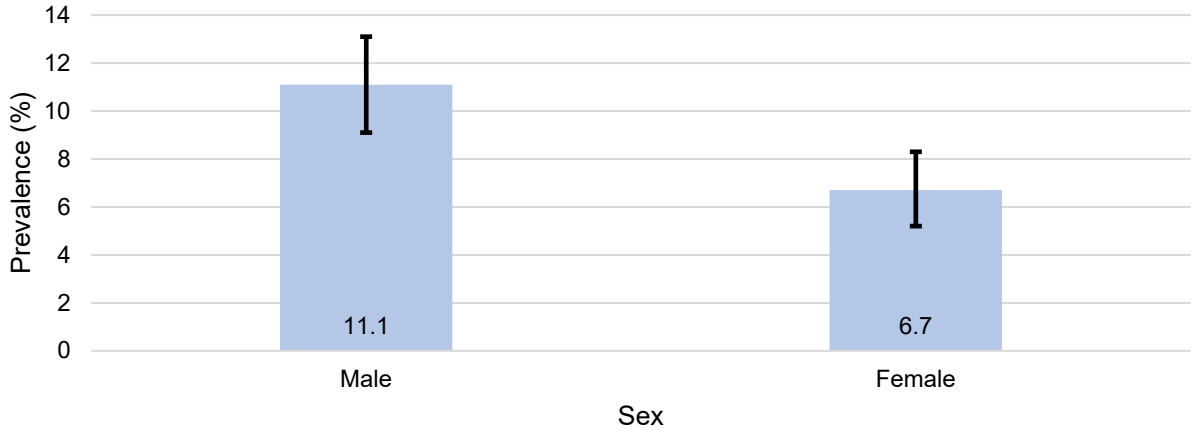
Figure 8. Lifetime and Current Asthma Prevalence in Children Under Age 18 Years, Kansas 2003-2016*



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.
*Note: BRFSS weighting methodology is different for data after 2010; therefore, BRFSS data from 2010 and earlier cannot be directly compared to BRFSS data from 2011 and after. The difference observed may be due to the difference in methodology and not an actual difference in prevalence.

In contrast to adults, male children had a higher prevalence of asthma in Kansas than female children, 11.1% (CI: 9.1%-13.1%) compared to 6.7% (CI: 5.2%-8.3%), respectively (Figure 9). This difference in prevalence among male and female children was statistically significant.

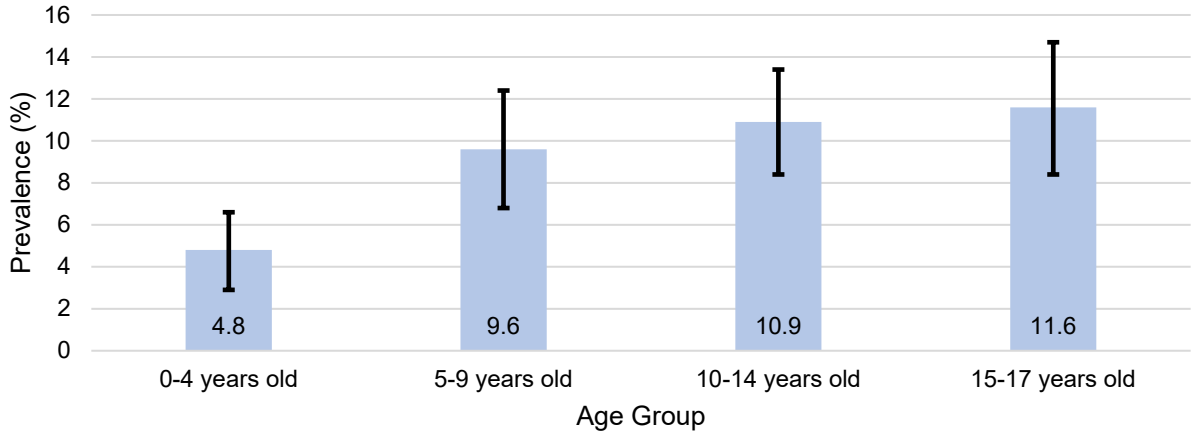
Figure 9. Prevalence of Current Asthma Among Children Under Age 18 Years by Sex, Kansas 2016



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Among Kansas children under 18 years old, the 15-17 years old age group had the highest prevalence of current asthma in 2016 at 11.6% (CI: 8.4%-14.7%) (Figure 10). The 0-4 years old age group had the lowest prevalence of current asthma at 4.8% (CI: 2.9%-6.6%). The prevalence of current childhood asthma appears to increase with age during adolescence. The difference in current asthma prevalence among the 0-4 years old age group was statistically significantly lower than the prevalence of asthma in all other age groups.

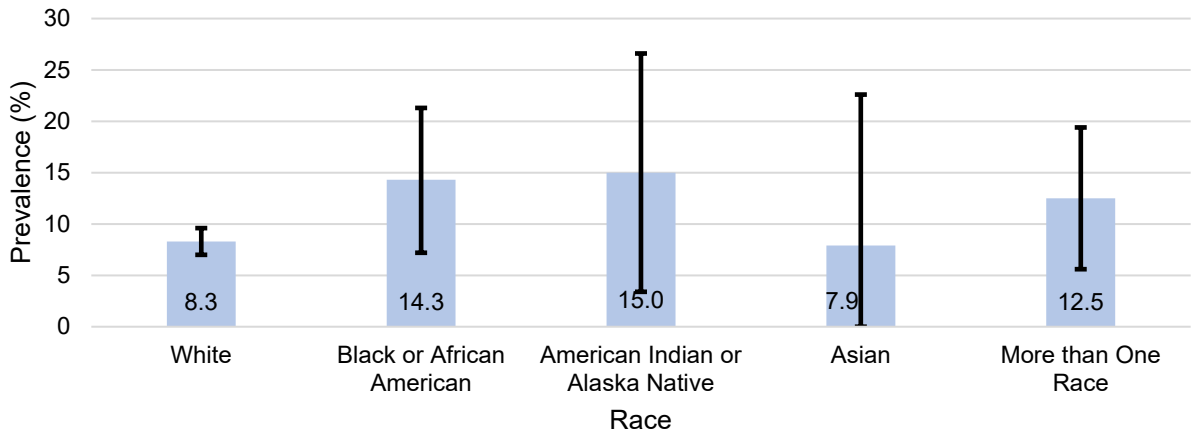
Figure 10. Prevalence of Current Asthma Among Children Under Age 18 Years by Age Group, Kansas 2016



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Among children in Kansas, those that were reported by a parent or guardian as American Indian or Alaska Native had the highest prevalence of current asthma in 2016 at 15% (CI: 3.4%-26.6%) (Figure 11). Those that identified as Asian only had the lowest prevalence of current asthma at 7.9% (CI: 0.0%-22.6%). Asthma prevalence estimates were not statistically significantly different among races. Confidence intervals for these prevalence estimates were wide.

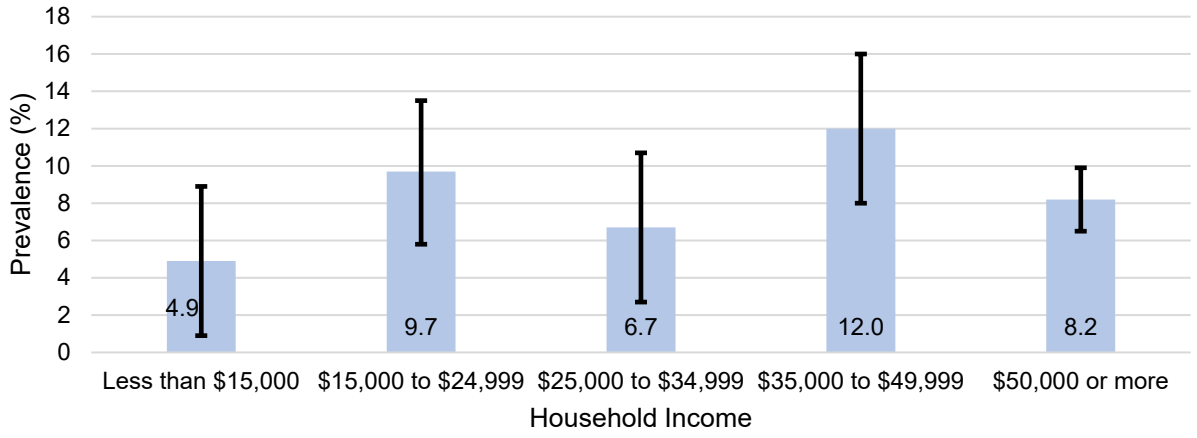
Figure 11. Prevalence of Current Asthma Among Children Under Age 18 Years by Race, Kansas 2016



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Among children in Kansas, those living in households with an annual household income of $35,000 to $49,999 had the highest prevalence of current asthma in 2016 at 12% (CI: 8.0%-16.0%) (Figure 12). Unlike adults in Kansas, those that live in households with an annual income of less than $15,000 had lowest the prevalence of current asthma at 4.9% (CI: 0.9%-8.9%). Unlike adults in Kansas, the prevalence of asthma did not appear to correlate with household income. Asthma prevalence estimates were not statistically significantly different among household income categories.

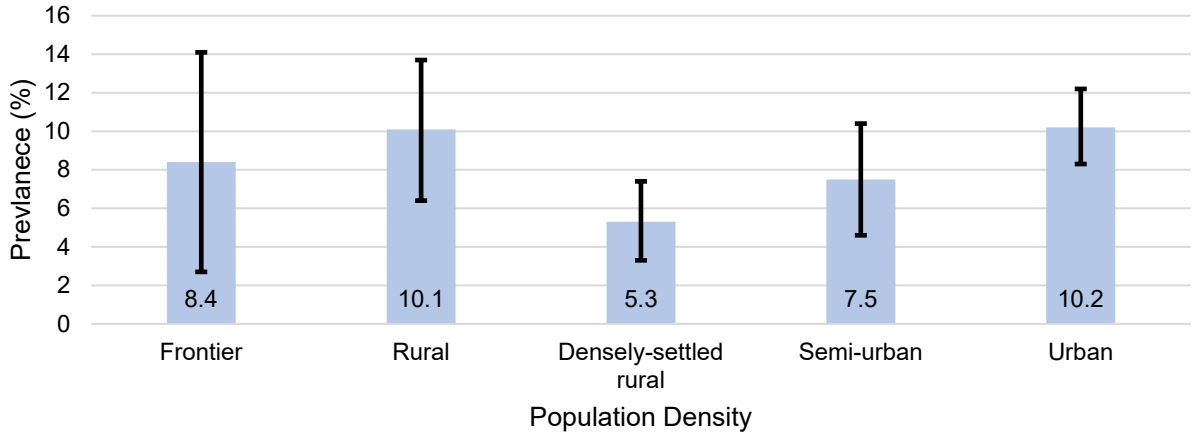
Figure 12. Prevalence of Current Asthma Among Children Under Age 18 Years by Household Income, Kansas 2016



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Among children in Kansas, those that live in an urban county had the highest prevalence of current asthma in 2016 at 10.2% (CI: 6.4%-13.7%) (Figure 13). Those that live in a densely-settled rural county had the lowest prevalence of current asthma at 5.3% (CI: 3.3%-7.4%). The difference in current asthma prevalence was statistically significantly lower between those in a densely-settled rural county and those that were in an urban county.

Figure 13. Prevalence of Current Asthma Among Children Under Age 18 Years by Population Density, Kansas 2016



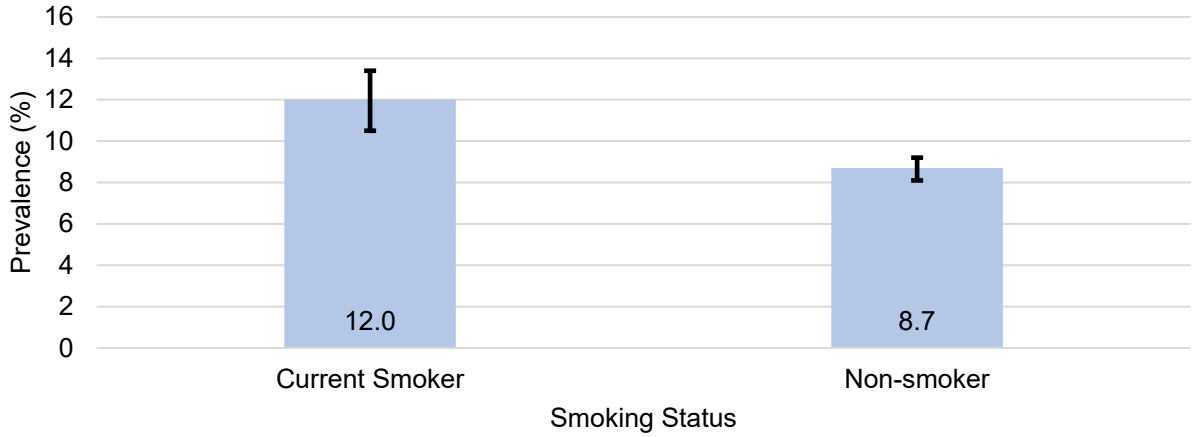
Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Asthma Risk Factors

Risk factors for asthma can include both personal health behaviors and other external circumstances that increase the likelihood that an individual will experience asthma episodes. Some of these risk factors include smoking, obesity, family history, outdoor air quality, and other indoor and outdoor environmental factors. Because asthma involves many risk factors, no one risk factor can explain asthma experienced by Kansans. Smoking and obesity risk factors were assessed using the BRFSS survey. Obesity was assessed based on body mass index (BMI). BMI is a calculation that uses an individual's height and weight to determine if they are underweight, normal weight, overweight, or obese (14). Air quality was assessed using monitor and modeled data for $PM_{2.5}$. $PM_{2.5}$ stands for particulate matter that is 2.5 microns in diameter or smaller and can come from smoke or haze. High levels of $PM_{2.5}$ can decrease lung functions and may trigger an asthma attack (15). Air quality data are available from the Kansas Environmental Public Health Tracking (EPHT) Program.

Current adult smokers in Kansas had an asthma prevalence of 12% (CI: 10.5%-13.4%) in 2017 (Figure 14). In comparison, non-smokers had an asthma prevalence of 8.7% (CI: 8.1%-9.2%). This difference was statistically significantly different.

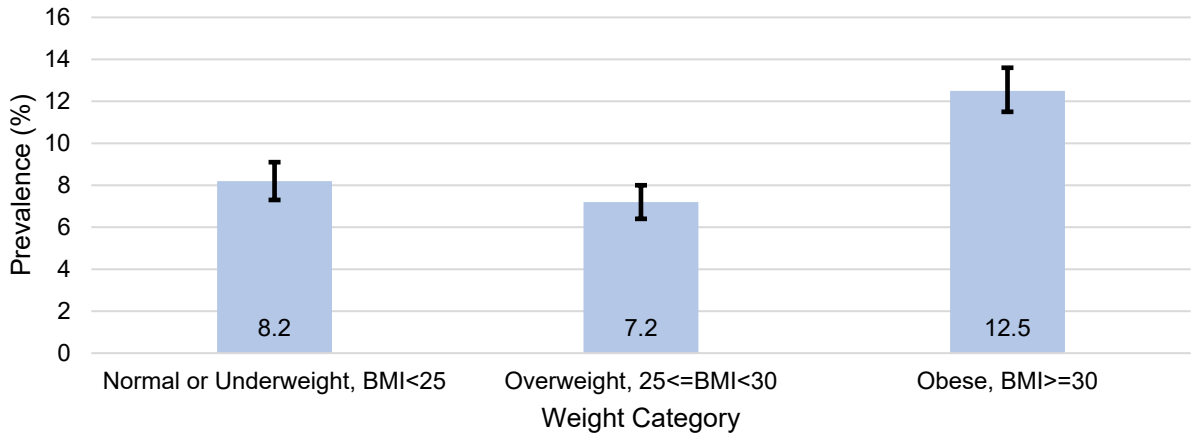
Figure 14. Prevalence of Current Asthma Among Adults Age 18 Years and Older by Smoking Status, Kansas 2017



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Adult Kansans that were considered obese (BMI greater than or equal to 30) had the highest asthma prevalence at 12.5% (CI: 11.5%-13.6%) (Figure 15). Adults that were considered overweight (BMI 25-29) and adults that were considered normal or underweight (BMI of less than 25) both had an asthma prevalence that was statistically significantly lower than the prevalence of those that were obese (7.2%, CI: 6.4%-8.0% and 8.2%, CI: 7.3%-9.1%, respectively).

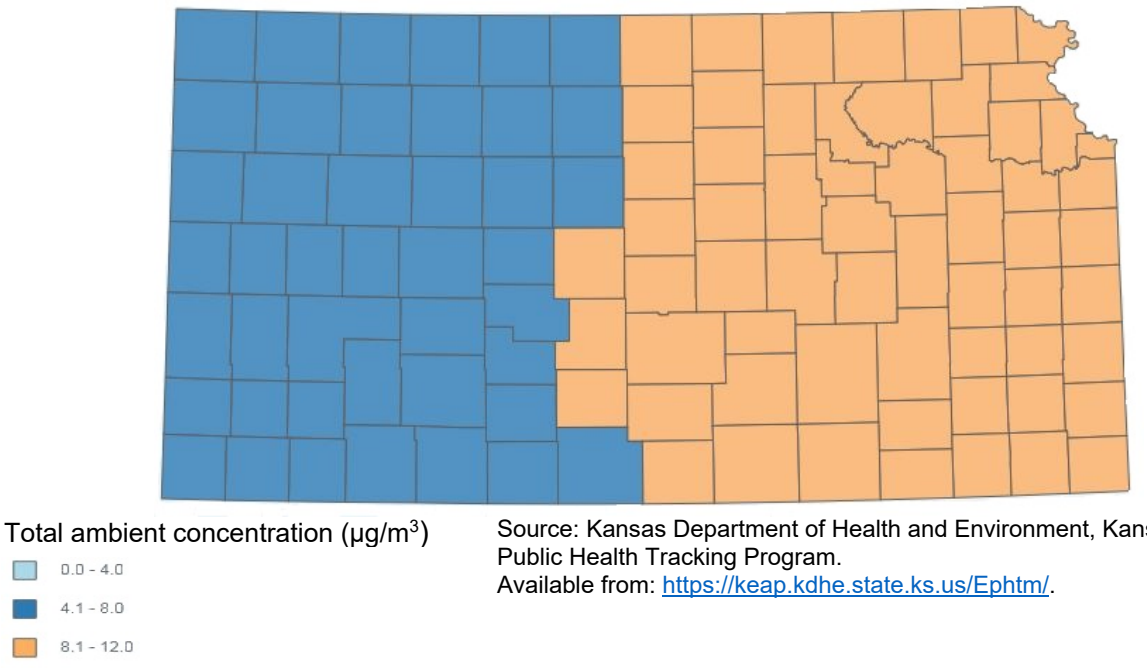
Figure 15. Prevalence of Current Asthma Among Adults Age 18 Years and Older by Weight Category, Kansas 2017



Source: Kansas Department of Health and Environment, Behavioral Risk Factor Surveillance System. Available from: http://www.kdheks.gov/brfss/index.html.

Modeled data from 2012 based on air monitors from six counties in Kansas indicate that the west side of Kansas has a total ambient concentration of $PM_{2.5}$ of 4.1-8.0 micrograms per cubic meter (µg/m^3) (Map 2). The east side of Kansas is modeled slightly higher at 8.1-12.0 µg/m^3. These estimates are all below the National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$, which is 12.0 µg/m^3.

Map 2. Annual Average Ambient Concentration of $PM_{2.5}$ in Micrograms per Cubic Meter, Monitor and Modeled, Kansas 2012



Source: Kansas Department of Health and Environment, Kansas Environmental Public Health Tracking Program.
Available from: https://keap.kdhe.state.ks.us/Ephtm/.

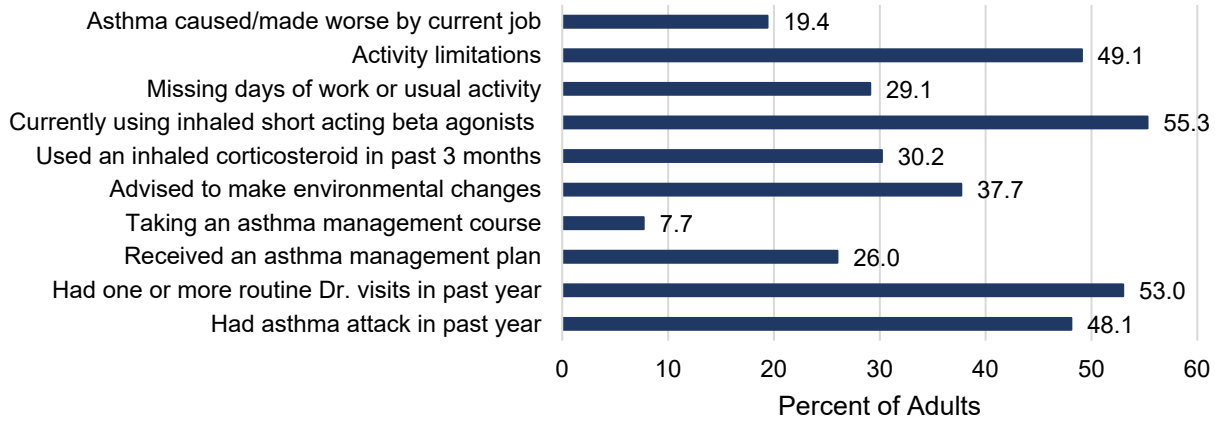
Asthma Management

Quality of life among persons with asthma can be greatly improved by controlling their disease. Asthma management is improved when their patient has a greater control of the asthma symptoms. Patient education by physicians can help people learn what to do during an asthma attack or episode. To help prevent serious health effects of asthma, persons with asthma need to learn how to identify the early signs of an asthma attack. In addition to education, physicians should help patients with asthma develop an asthma action plan. Both measures will prevent serious attacks leading to an ED visit and/or hospitalization. Finally, the use of corticosteroids may improve asthma management and prevent asthma attacks (16,17).

In 2015, among adults 18 years and older with current asthma, 53.0% (CI: 47.7%-58.3%) had at least one routine doctor visit in the past year, but only about one-quarter (26.0%, CI: 21.1%-30.9%) had received an asthma management plan (Figure 16). Over half of adults with current asthma use inhaled short-acting beta agonists and 30.2% (CI: 25.7%-34.7%) had used an inhaled corticosteroid in the past 3 months. An estimated 37.7% (CI: 32.4%-43.0%) of adults with current asthma were advised to make changes in their environment due to their asthma and nearly 20% (19.4%, CI: 14.7%-24.1%) had asthma that was either caused or made worse by their current job.

When asthma is not managed well, more adverse reactions from asthma can occur. Nearly half of adults with current asthma reported that they had activity limitations from their asthma and about one-third missed one or more days of work or usual activity. An estimated 48.1% (CI: 42.8%-53.4%) of adults with current asthma experienced an asthma attack in the last year.

Figure 16. Asthma Management Among Adults Age 18 Years and Older with Current Asthma, Kansas 2015

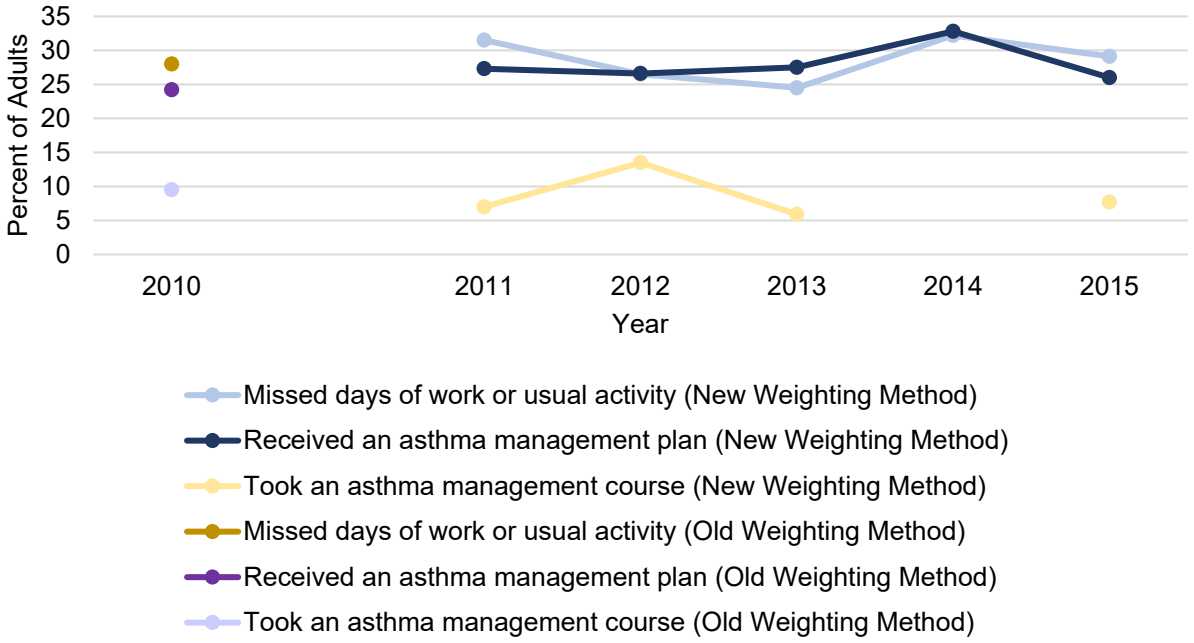


Source: Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/brfss/acbs/2015_tables_LLCP.html.

Among adults 18 years and older with current asthma, the estimates of the prevalence of asthma management have gone up and down over the 2010-2015 period (Figure 17). The percent of those that received an asthma management plan was slightly higher in 2015 than 2010 (26.0%, CI: 21.1%-30.9% and 24.2%, CI: 16.4%-32.0%, respectively). At the same time, the percentage of persons with asthma who reported missing days of work or usual activity has

increased (from 28.0, CI: 19.4%-36.6% in 2010 to 29.1%, CI: 24.2%-34.0% in 2015) and those taking an asthma management course has decreased (from 9.5%, CI: 5.4%-13.6% in 2010 to 7.7%, CI: 5.3%-10.1% in 2015). Overall, compared to 2010, the estimated percent of adults that are missing days of work of usual activity, that have received an asthma management plan, and are taking an asthma management course are similar in 2015 and there was no significant difference.

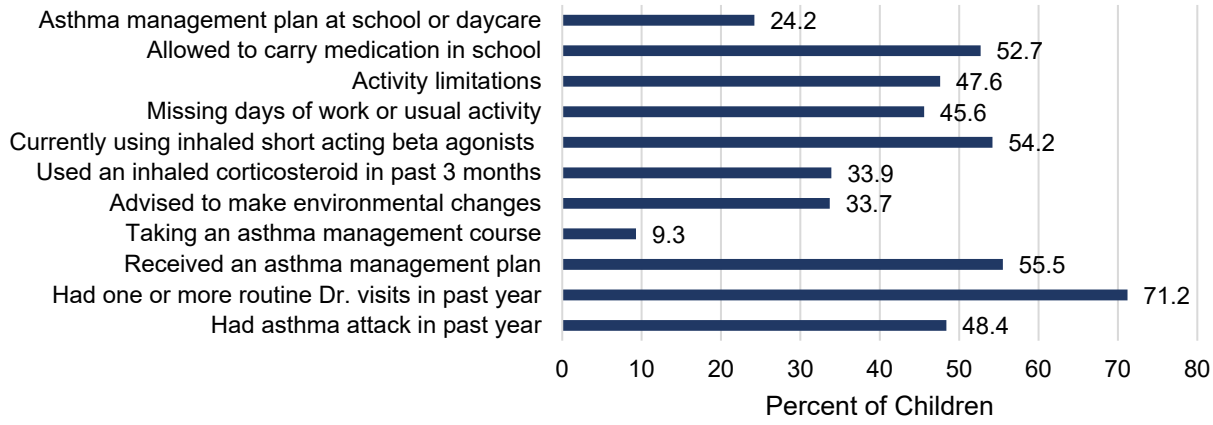
Figure 17. Asthma Management Among Adults Age 18 Years and Older with Current Asthma, Kansas 2010-2015



Source: Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/brfss/acbs/index.htm.
Note: Asthma management course estimate data is not available for 2014 for Kansas because data did not meet denominator requirements for state estimates in 2014.
Note: Behavioral Risk Factor Surveillance System (BRFSS) weighting methodology is different for data after 2010; therefore, BRFSS data from 2010 and earlier cannot be directly compared to BRFSS data from 2011 and after. The difference observed may be due to the difference in methodology and not an actual difference in prevalence.

Among children less than 18 years old with current asthma, 71.2% (CI: 60.6%-80.3%) had at least one routine doctor visit in the past year and over half had received an asthma management plan according to estimates from 2012-2014 (Figure 18). Over half of children with current asthma use inhaled short-acting beta agonists and about one-third had used an inhaled corticosteroid in the past 3 months. Nearly half of children had had an asthma attack in the past year and 45.6% (CI: 35.5%-56.2%) missed days of work/school or usual activity. While over half could carry medication in school, only about one-fourth had an asthma management plan at school or daycare. The percentage of children that had an asthma management plan was higher than adults (55.5%, CI: 45.4%-65.1% vs 26.0%, CI: 21.1%-30.9%) and the percentage of children that reported missing days of work/school or usual activity was higher than adults (45.6%, CI: 35.5%-56.2% vs 29.1%, CI: 24.2%-34.0%, respectively). However, the percentage of children that has had an asthma attack in the past year was similar to adults.

Figure 18. Asthma Management Among Children Under Age 18 Years with Current Asthma, Kansas 2012-2014



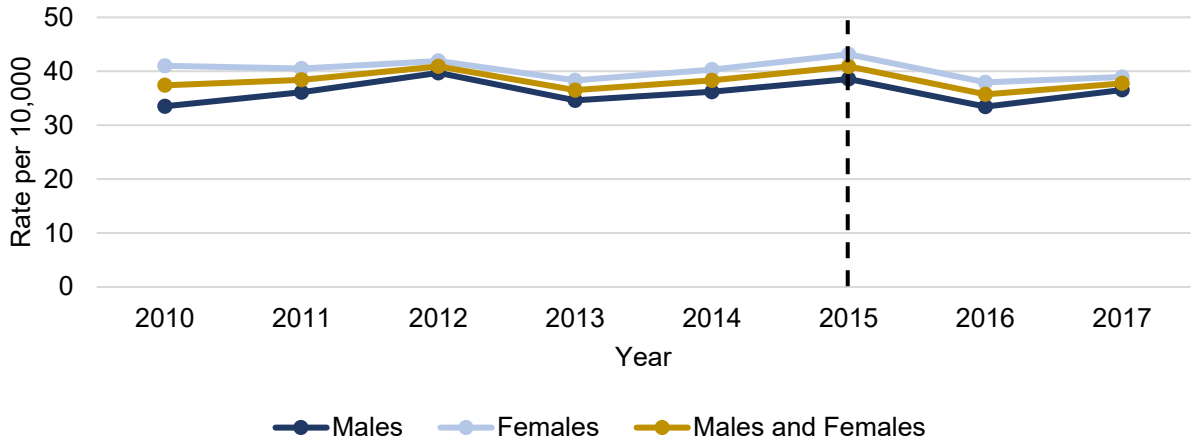
Source: Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/brfss/acbs/2012-2014_tables.html.
Note: Child asthma estimates from Behavioral Risk Factor Surveillance System combine 3 years of data to provide more stable estimates due to small sample sizes for individual years of data.

Asthma Emergency Department Visits and Hospitalizations

Asthma is one of the top 20 leading reasons for an emergency department (ED) visit in the United States (6). Nationally, more than 1.5 million ED visits include asthma as the primary diagnosis (6). Evaluating the use of the ED for asthma episodes helps measure the health care use of people with asthma. The rates of asthma ED visits per 10,000 Kansas residents were calculated using ED data from the Kansas Hospital Association and these calculated measures are available through the Kansas Environmental Public Health Tracking Program (Appendix A).

The age-adjusted rate of ED asthma visits has remained similar for males, females, and both sexes combined between the 2010-2017 period (Figure 19). In Kansas in 2017, females had a slightly higher rate of ED asthma visits than males (38.9 vs 36.5 per 10,000 population, respectively). The difference in the ED visit rate for males and females was similar in 2017 to what it was in 2010.

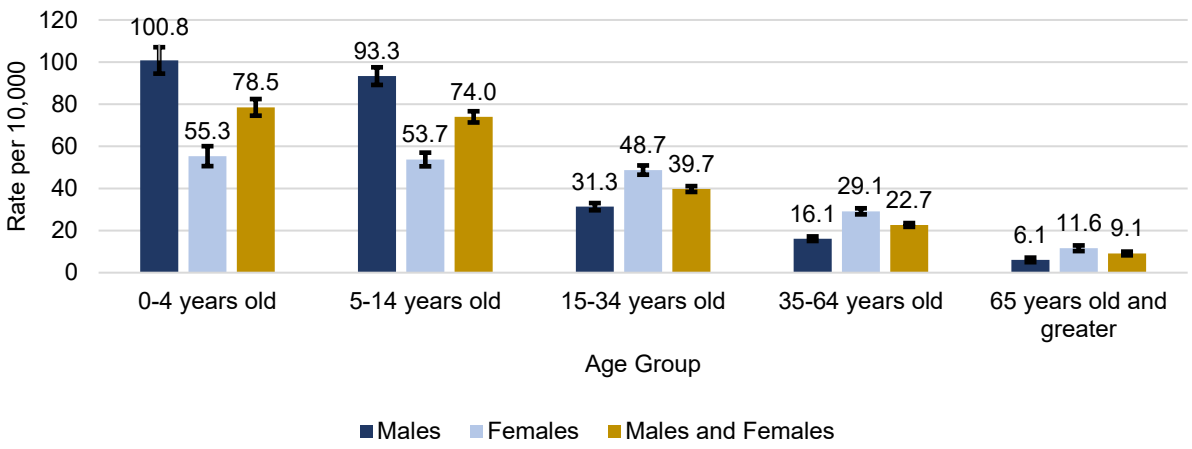
Figure 19. Age-Adjusted Rate of Asthma ED Visits by Sex, Kansas 2010-2017*



Source: Kansas Hospital Association.
*Note: The US transitioned from ICD-9-CM to ICD-10-CM on October 1, 2015. The difference in results before and after 2015 could be due to this coding change and not an actual difference in the number of events.

Females did not have a higher rate of asthma ED visits at every age. For age categories 0-4 years and 5-14 years, males (100.8, CI: 94.5-107.1 and 93.3, CI: 89.1-97.5 per 10,000 population, respectively) had a higher rate of ED visits for asthma than females (55.3, CI: 50.6-60.1 and 53.7, CI: 50.5-57.0 per 10,000 population, respectively) (Figure 20). This difference was statistically significantly different. For all other age categories, females had a higher rate of asthma ED visits than males; these differences were statistically significant. This reflects the prevalence data that estimated that males have a higher prevalence of current asthma than females as children, but not as adults. Those that are ages 0-4 years had the highest rate of ED visits for asthma in Kansas.

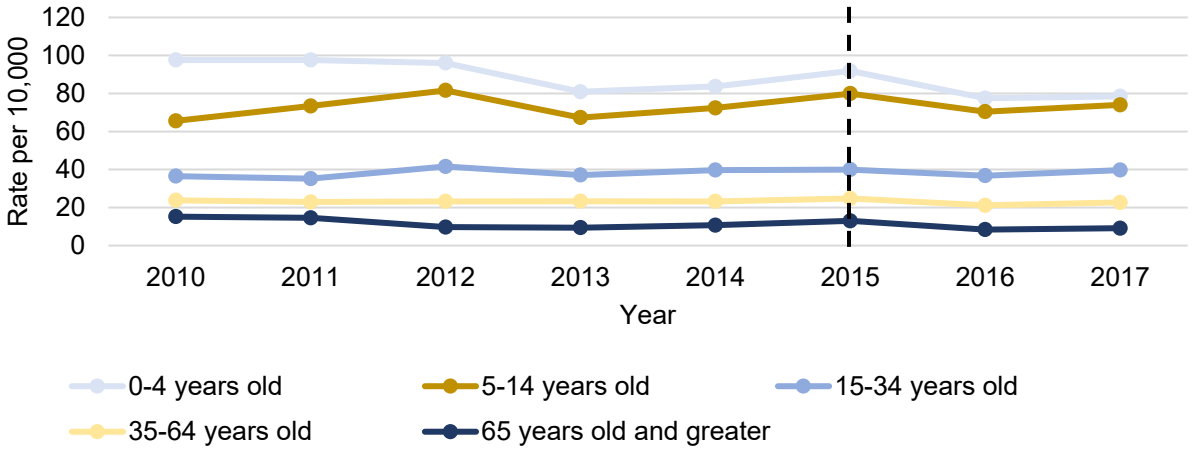
Figure 20. Rate of Asthma ED Visits by Sex and Age Group, Kansas 2017



Source: Kansas Hospital Association.

The rate of asthma ED visits experienced fluctuations for some age groups in the 2010-2017 period (Figure 21). Persons who were in the 0-4 years old and 65 years old and greater age group categories appear to have a slight decrease in the rate of asthma ED visits (97.6 to 78.5 and 15.2 to 9.1 per 10,000 population, respectively). The 5-14 years old age group appears to have a slight increase in the rate of asthma ED visits during the 8-year period (65.6 to 74.0 per 10,000 population, respectively). Both the 15-34 years old and 35-64 years old age groups appear to have little change in ED visit rates for asthma during this time.

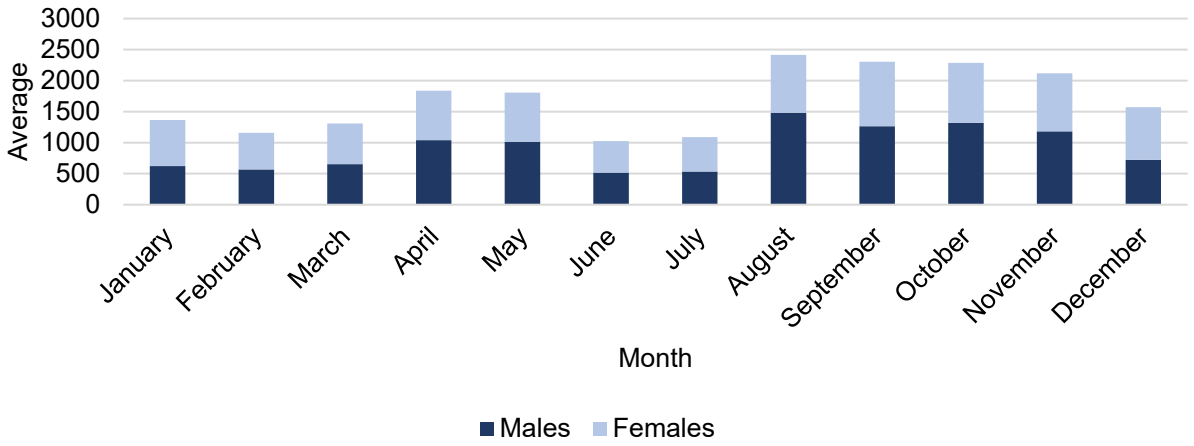
Figure 21. Rate of Asthma ED Visits by Age Group, Kansas 2010-2017*



Source: Kansas Hospital Association.
*Note: The US transitioned from ICD-9-CM to ICD-10-CM on October 1, 2015. The difference in results before and after 2015 could be due to this coding change and not an actual difference in the number of events.

In Kansas, over the 2013-2017 period, there was a higher average number of asthma ED visits during the months of August through November (Figure 22). There were also slightly higher averages in April and May. August had the highest average number of ED visits for males while September had the highest average number of ED visits for females (1,481.4 and 1,037.2, respectively). Both females and males had the lowest average number of ED visits in June (508.4 and 517.2, respectively). Peaks of ED visits in fall and spring may be related to allergen exposure, change in temperature, spring agricultural burning and increased respiratory infections related to going back to school.

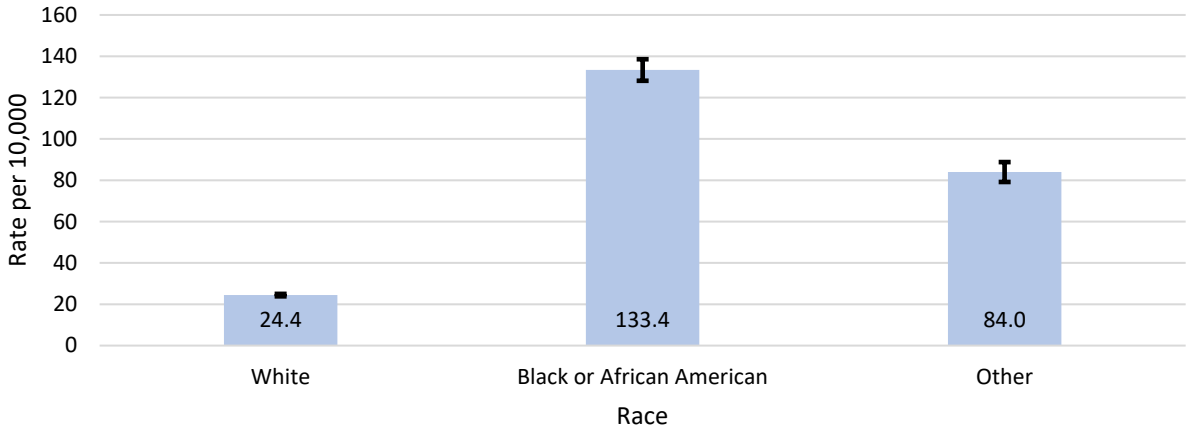
Figure 22. Average Number of Asthma ED Visits by Month and Sex, Kansas 2013-2017



Source: Kansas Hospital Association.

Those that were identified as white in hospital records had a lower rate of age-adjusted asthma ED visits than those that were identified as black or African American or a race other than white or black or African American (24.4, CI: 23.8-25.0; 133.4, CI: 128.2-138.6; and 84.0, CI: 79.2-88.8 per 10,000 population, respectively) (Figure 23). These differences were statistically significant. The asthma ED visit rates for black or African American Kansas was also statistically significantly higher than those identified as a race other than white or black or African American.

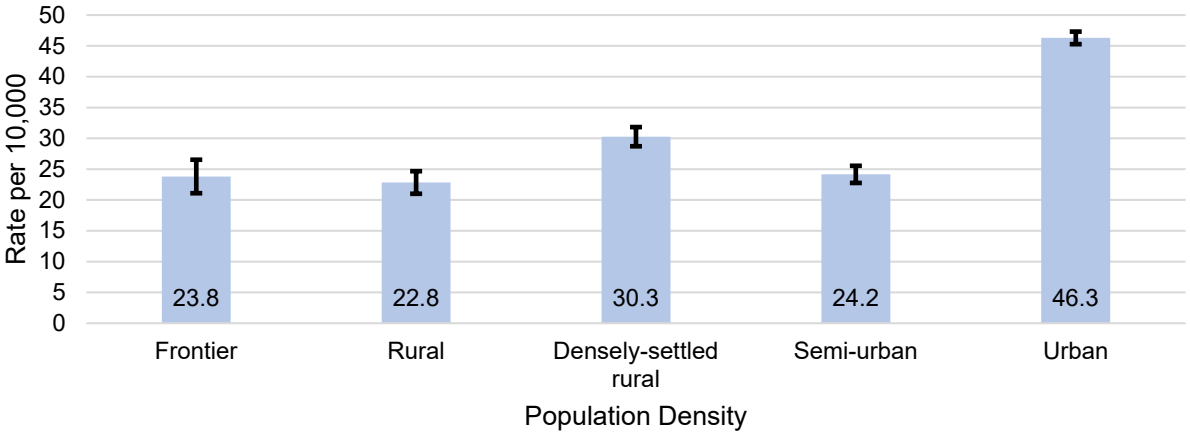
Figure 23. Age-Adjusted Rate of Asthma ED Visits by Race, Kansas 2017



Source: Kansas Hospital Association.

Those living in an urban county had a higher rate of age-adjusted asthma ED visits than those living in lower population density counties (46.3, CI: 45.3-47.3 per 10,000 population) (Figure 24). The difference between the rate of urban ED visits and all other population densities was statistically significant. Those living in densely-settled rural counties had a statistically significantly higher rate of asthma ED visits than those that lived in frontier, rural, and semi-urban counties.

Figure 24. Age-Adjusted Rate of Asthma ED Visits by Population Density, Kansas 2017

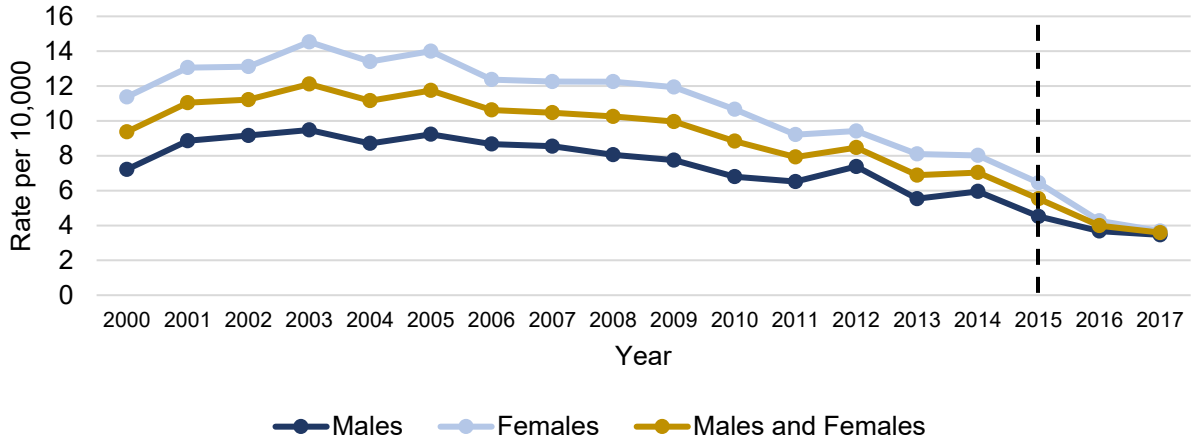


Source: Kansas Hospital Association.

Like ED use, hospitalizations due to asthma also help measure health care utilization by persons with asthma. For the next section, the hospital discharge data set from the Kansas Hospital Association was used to calculate the rate of asthma hospitalizations per 10,000 Kansas residents. The calculated measures are available through the Kansas Environmental Public Health Tracking Program (Appendix A).

For all years, females had a higher rate of asthma hospitalization than males (Figure 25). Since 2005, there has been a decline in asthma hospitalizations for both males and females until 2012. Since 2012, the rate of asthma hospitalizations has gone up and down, similar to the rate of asthma ED visits. Overall, the rate of asthma hospitalizations is lower for males, females, and males and females combined in 2017 than it was in 2000, but a change in hospital coding that occurred in 2015 may have contributed to this difference.

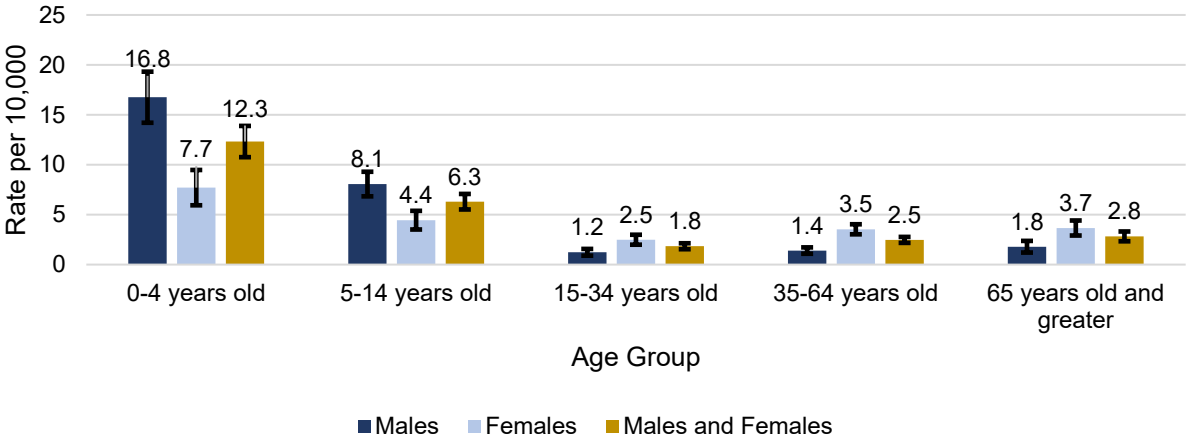
Figure 25. Age-Adjusted Rate of Asthma Hospitalizations by Sex, Kansas 2000-2017*



Source: Kansas Hospital Association
*Note: The US transitioned from ICD-9-CM to ICD-10-CM on October 1, 2015. Difference in results before and after 2015 could be due to this coding change and not an actual difference in the number of events.

Like the rate of asthma ED visits, males experienced a higher rate of asthma hospitalizations in the 0-4 (16.8, CI: 14.2-19.3 per 10,000 population) and 5-14 years old (8.1, CI: 6.8-9.3 per 10,000 population) age groups (Figure 26). These higher rates were statistically significantly higher than females of the same age groups (7.7, CI: 5.9-9.5 and 4.4, CI: 3.5-5.4 per 10,000 population, respectively). Because males have a higher prevalence of current asthma in childhood while females have a higher prevalence in adulthood, it is expected that males may have a higher rate of health care utilization at these younger ages. Females had a higher rate than males at all age groups older than 14 years old, these rate differences were also statistically significant. Like ED visits, those that were age 0-4 years had the highest rate of asthma hospitalization compared to other age groups, this difference was statistically significant for both males and females.

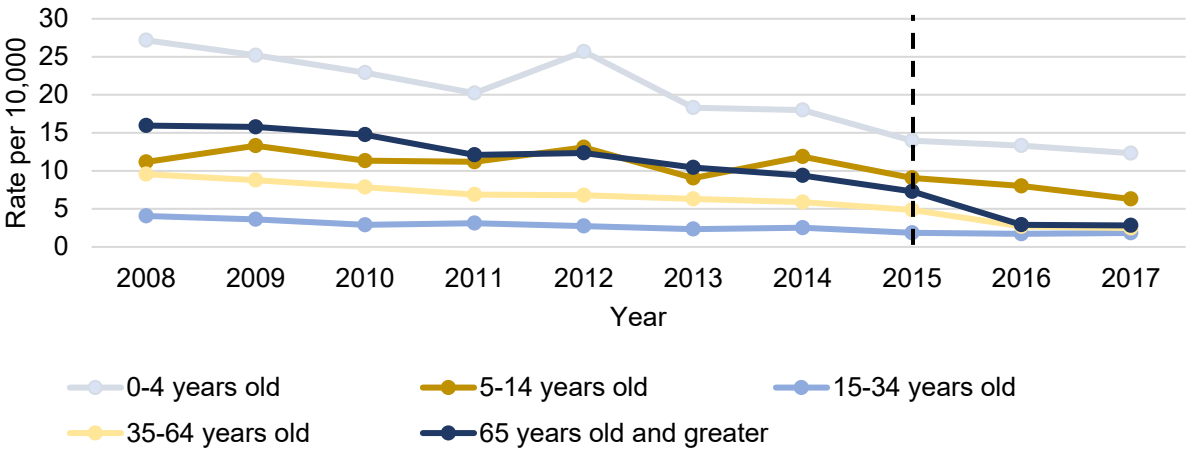
Figure 26. Rate of Asthma Hospitalizations by Sex and Age Group, Kansas 2017



Source: Kansas Hospital Association.

The rate of asthma hospitalizations has declined for all age groups in the 2008-2017 period (Figure 27). It is important to note that the US transitioned from ICD-9-CM to ICD-10-CM coding on October 1, 2015, therefore the difference in results from before 2015 and after 2015 could be related to this coding change. From 2008 to 2014, prior to the implementation of the diagnostic code change, all age groups except the 5-14 years old were experiencing a decline in asthma hospitalization rates.

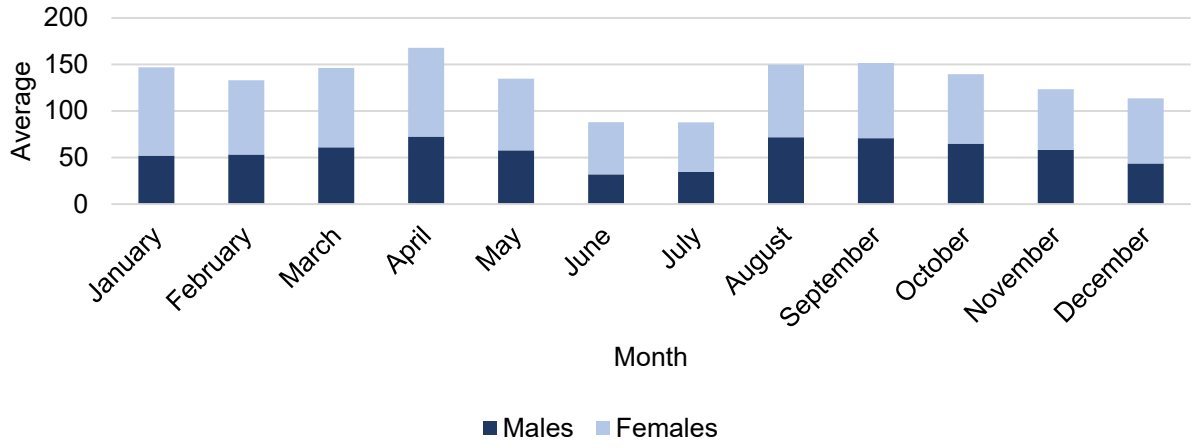
Figure 27. Rate of Asthma Hospitalization by Age Group, Kansas 2008-2017*



Source: Kansas Hospital Association
*Note: The US transitioned from ICD-9-CM to ICD-10-CM on October 1, 2015. The difference in results before and after 2015 could be due to this coding change and not an actual difference in the number of events.

In Kansas, for the 2013-2017 period, very warm weather months had a lower average number of asthma hospitalizations compared to months with cooler weather (Figure 28). April had the highest average number of hospitalization for both males and females (72.6 and 95.4, respectively). Females had the lowest average number of hospitalizations in July while males had the lowest average number of hospitalizations in June (53.2 and 32.0, respectively). Peaks of hospitalizations in fall and spring may be related to allergen exposure, spring agricultural burning, change in temperature, and increased respiratory infections related to going back to school.

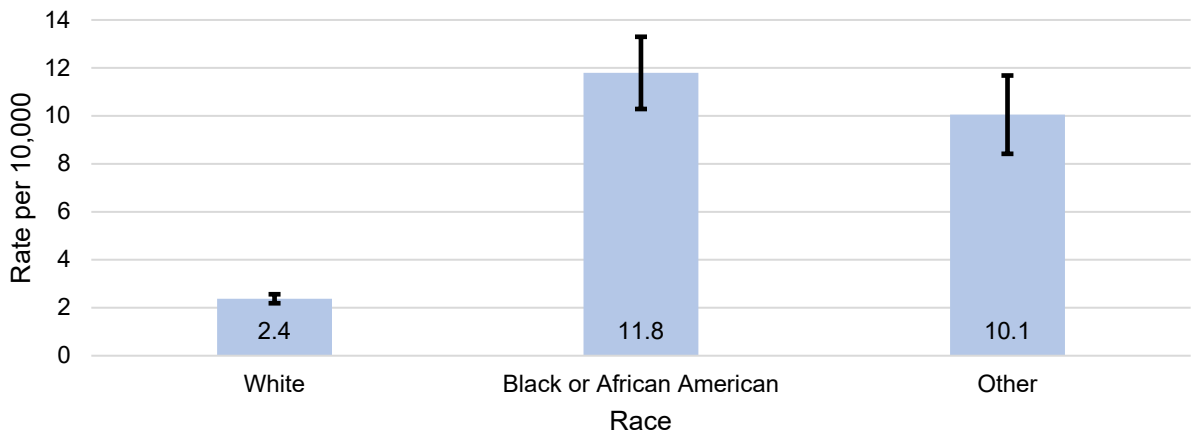
Figure 28. Average Number of Asthma Hospitalizations by Month and Sex, Kansas 2013-2017



Source: Kansas Hospital Association.

Similar to ED visits, those that were identified as white in hospital records had a lower rate of age-adjusted asthma hospitalizations than those that were identified as black or African American or a race other than white or black or African American (2.4, CI: 2.2-2.6; 11.8, CI: 10.3-13.3; and 10.8, CI: 8.4-11.7 per 10,000 population, respectively) (Figure 29). These differences were statistically significant. Unlike asthma ED visit rates, the rates of asthma hospitalizations for black or African American Kansas was not statistically significantly higher than those identified as a race other than white or black or African American.

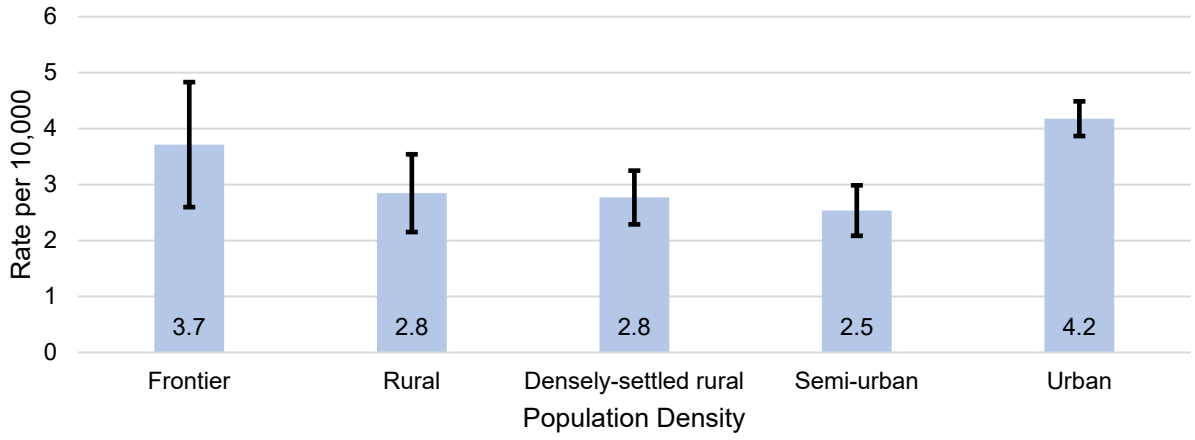
Figure 29. Age-Adjusted Rate of Asthma Hospitalizations by Race, Kansas 2017



Source: Kansas Hospital Association.

Those living in an urban county (4.2, CI: 3.9-4.5 per 10,000 population) had a higher rate of age-adjusted asthma hospitalizations than those living in lower population density counties (Figure 30). The difference between the rate of urban hospitalizations and all other population densities except frontier was statistically significant. No other differences in rates between different population densities were statistically significant.

Figure 30. Age-Adjusted Rate of Asthma Hospitalizations by Population Density, Kansas 2017

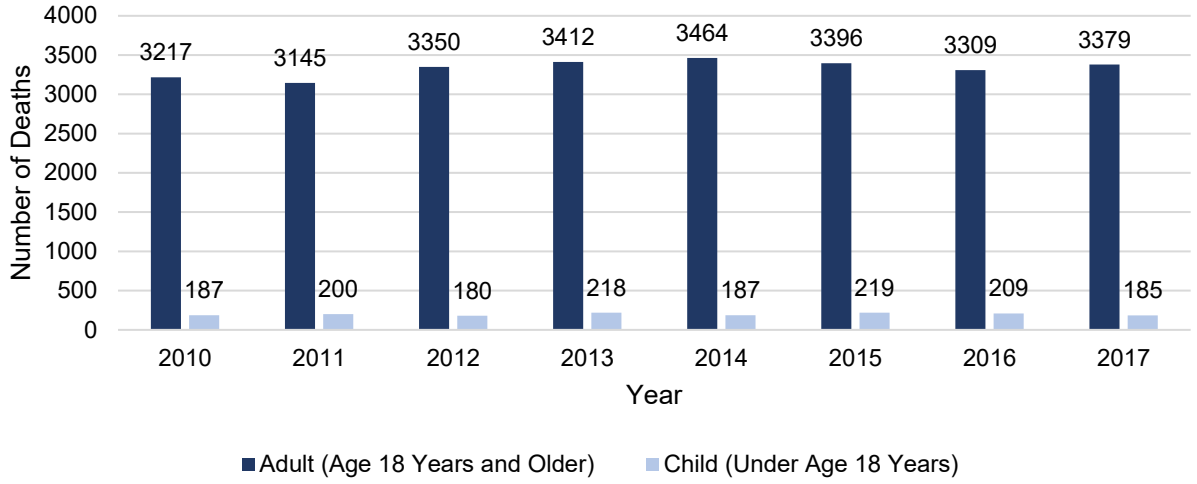


Source: Kansas Hospital Association.

Asthma Mortality

Each year, asthma causes thousands of deaths in the US. From 2010 to 2017, there were more than 3,500 deaths on average in the US due to asthma (Appendix A). Asthma deaths in adults were highest in 2014 at 3,464 and highest in children in 2015 at 219 (Figure 31). Overall, asthma deaths have increased since 2010 and were highest in 2014. Proper management of asthma allows individuals to live with few limitations to activities and without life-threatening asthma episodes.

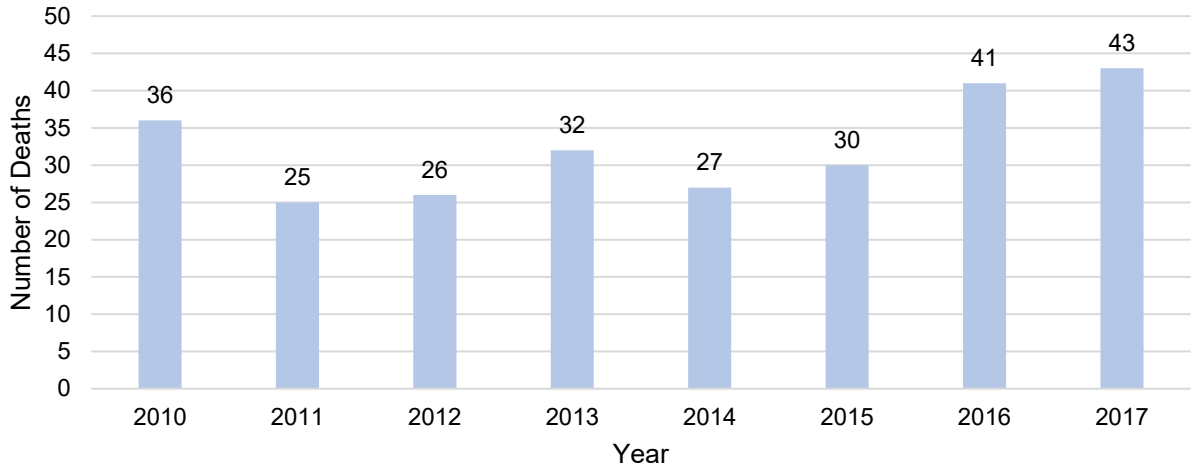
Figure 31. Number of Asthma Deaths, US 2010-2017



Source: Centers for Disease Control and Prevention. Available from https://wonder.cdc.gov/ucd-icd10.html.

From 2010-2017, Kansas had the highest number of asthma deaths in 2017 at 43 (Figure 32). During this same period, the lowest number of asthma deaths occurred in 2011 (25 deaths). Asthma deaths in adults and children were combined due to child asthma mortality counts of less than 5.

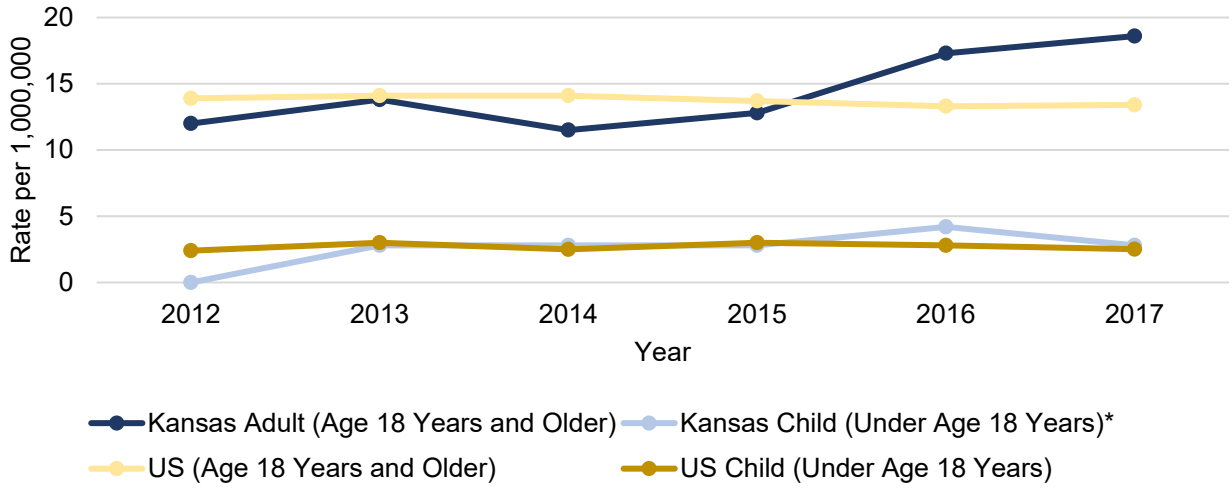
Figure 32. Number of Asthma Deaths, Kansas, 2010-2017



Source: Kansas Department of Health and Environment Bureau of Epidemiology and Public Health Informatics

In recent years, Kansas has had a higher mortality rate from asthma compared to the US (Figure 33). Kansas adult rates appear to be increasing, but small numbers in Kansas caused rate increases that are not statistically significant. The rate in the US for adults and children has remained steady from 2012 to 2017. The rate in Kansas has gone up and down over this period, with its lowest rate for adults in 2014 at 11.5 (CI: 7.0-16.0) deaths per 1,000,000 population and peaking in 2017 at 18.6 (CI: 12.9-24.3) asthma deaths per 1,000,000. The rate for children in Kansas was lowest in 2012 and the highest in 2016 (0 and 4.2, CI: 0-8.9 deaths per 1,000,000, respectively). For both children and adults in Kansas and the US, the trend in asthma mortality did not significantly change from 2012 to 2017.

Figure 33. Asthma Mortality Rate, Kansas and US 2012-2017

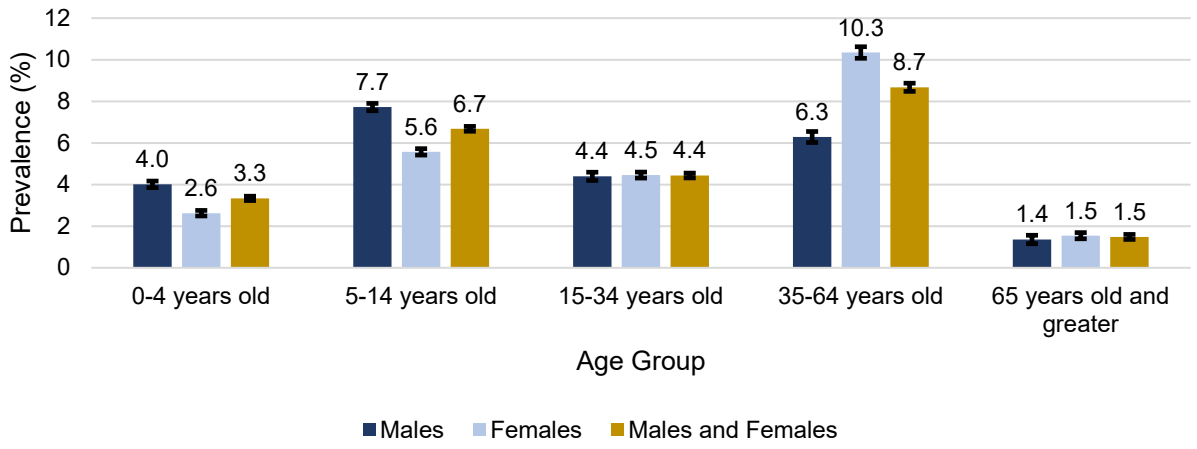


Source: Kansas Department of Health and Environment Bureau of Epidemiology and Public Health Informatics and Centers for Disease Control and Prevention. Available from https://wonder.cdc.gov/ucd-icd10.html.
*Asthma mortality rates for children under age 18 years old in Kansas may be unstable. The relative standard error (RSE) for these rates are greater than 30%, therefore, they are considered statistically unreliable.

Asthma in Medicaid Recipients

Medicaid is a program that provides health care coverage to low-income children and adults (Appendix A). Persistent asthma was used to define asthma in the Medicaid population because data on current asthma was not available. Prevalence of persistent asthma among Medicaid recipients was calculated from data obtained from the Kansas Department of Health and Environment, Division of Health Care Finance. Data obtained included the total number of individuals enrolled in Medicaid by age and sex and the total number of individuals enrolled with persistent asthma by age and sex. Persistent asthma was classified by using the Healthcare Effectiveness Data and Information Set (HEDIS) definition. Individuals with persistent asthma were those fulfilling at least one of four criteria during the past year: 1) one or more ED visits for asthma, 2) one or more hospitalization with asthma as the principal diagnosis, 3) at least four outpatient visits with asthma as the principal diagnosis and two or more asthma medication-dispensing events, or 4) four or more asthma medication-dispensing events. For the purposes of this report, the HEDIS persistent asthma definition was also extended to include individuals that were under 5 years old.

Figure 34. Percent of Medicaid Recipients with Persistent Asthma by Sex and Age Group, Kansas 2017

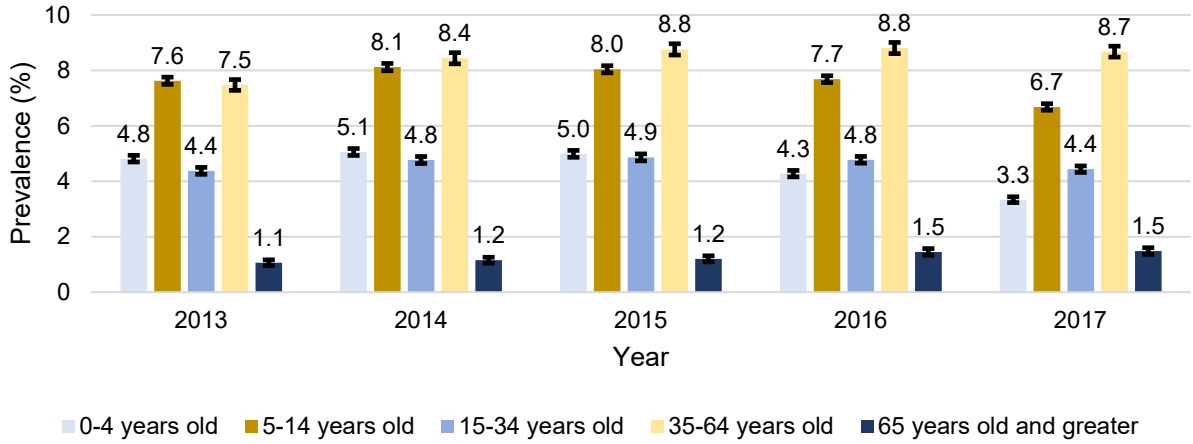


Source: Kansas Department of Health and Environment, Division of Health Care Finance.

Similar to the overall Kansas population, the Medicaid population in Kansas has a higher percentage of males from age 0-4 years (4.0, CI: 3.9%-4.2%) and 5-14 years (7.7%, CI: 7.6%-7.9%) with persistent asthma compared to females (2.6%, CI: 2.5%-2.8% and 5.6%, CI: 5.4%-5.7%, respectively) (Figure 34). The difference in the proportion of male and female Medicaid recipients with persistent asthma was statistically significantly different for these age groups. Females had a higher prevalence of persistent asthma than males in the 35-64 years age group (10.3%, CI: 10.1%-10.6% and 6.3%, CI: 6.0%-6.6%, respectively), this difference was statistically significant. The prevalence of persistent asthma among 0-4 years old and 5-14 years old Medicaid recipients was slightly lower in 2017 (3.3%, CI: 3.2%-3.4% and 6.7%, CI: 6.6%-6.8%, respectively) than it was in 2013 (4.8%, CI: 4.7%-4.9% and 7.6%, CI: 7.5%-7.8%, respectively), while all other age groups remained the same or increased (Figure 35). The

difference in proportions of Medicaid recipients with persistent asthma in 2013 and 2017 was statistically significant for all age groups except the 15-34 years old group.

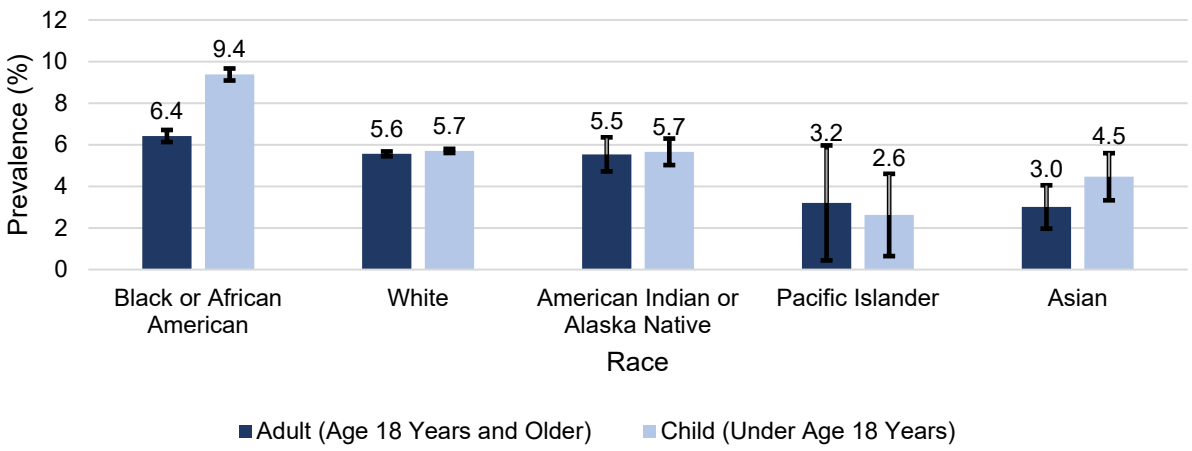
Figure 35: Percent of Medicaid Recipients with Persistent Asthma by Age Group, Kansas 2013-2017



Source: Kansas Department of Health and Environment, Division of Health Care Finance.

Children enrolled in Medicaid that were black or African American had a higher prevalence of persistent asthma than children of other races at 9.4% (CI: 9.1%-9.7%) (Figure 36). This difference was statistically significant. Children enrolled in Medicaid that were Pacific Islander had a lower prevalence of persistent asthma than children of other races at 2.6% (CI: 0.6%-4.6%). This difference was significant for black or African American children, white children, and American Indian or Alaska Native children. Adults enrolled in Medicaid that were black or African American had a higher prevalence of persistent asthma than adults of other races at 6.4% (CI: 6.1%-6.7%). This difference was statistically significant compared to white adults, Pacific Islander, and Asian adults. Adults enrolled in Medicaid that were Asian had a lower prevalence of persistent asthma than adults of other races at 3.0% (CI: 2.0%-4.1%). This difference was statistically significant compared to black or African American, white, and American Indian or Alaska Native adults. Adults enrolled in Medicaid that were black or African American had a statistically significantly lower prevalence of persistent asthma than children of the same race. No other differences in rates between different races were statistically significant. Comparisons of race within Medicaid data should be interpreted with caution; 21.2% of children and 7.9% of adults enrolled in Medicaid for 2017 had unknown information for race. Because of this, it is possible that what appears to be differences in the prevalence of persistent asthma by race could be attributed to the missing information.

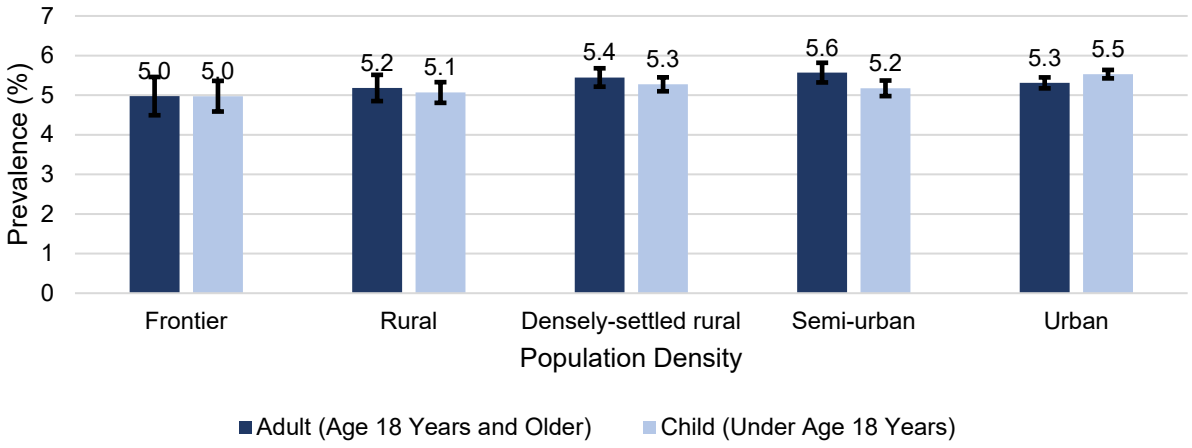
Figure 36. Percent of Medicaid Recipients* with Persistent Asthma by Race and Age Group, Kansas 2017



Source: Kansas Department of Health and Environment, Division of Health Care Finance.
*Note: A significant proportion of racial information for those enrolled in Medicaid is unknown. The difference in prevalence by race could be due to this unknown information and not an actual difference in prevalence.

Medicaid children living in an urban county had a higher prevalence of persistent asthma than those living in lower population density counties at 5.5% (CI: 5.4%-5.6%) (Figure 37). The difference between the rate of persistent asthma in children living in urban counties and the rates of children living in frontier, rural, and semi-urban counties was statistically significant. Children living in a frontier county had the lower prevalence of persistent asthma compared to children living in higher population density counties (5.0%, CI: 4.6%-<5.4%). Similar to the children, adults identified as living in a frontier county had a lower prevalence of persistent asthma (5.0%, CI: 4.5%-5.5%) than adults living in counties of higher population densities. However, adults living in semi-urban counties had the highest prevalence of asthma (5.6%, CI: 5.3%-5.8%). These differences were not statistically significant.

Figure 37. Percent of Medicaid Recipients with Persistent Asthma by Population Density and Age Group, Kansas 2017



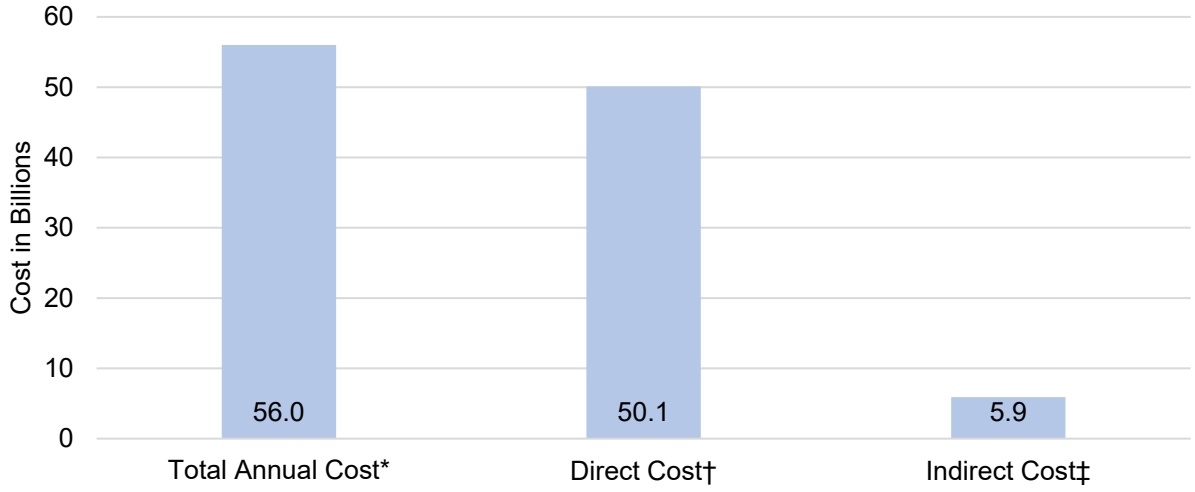
Source: Kansas Department of Health and Environment, Division of Health Care Finance.

Economic Burden of Asthma

Asthma burdens both society and individuals. The burden of asthma includes direct costs for treatments and medications. The direct medical costs include costs for primary care consultations, hospital ED visits and hospital admissions, ambulance and other transportation, and equipment such as peak flow meters (18). It can also include indirect costs from lost days of work and school (19). Those with comorbidities, such as depression or hypertension, can have increased costs associated with productivity and higher total hospital costs for hospital admissions (19,20).

For the US in 2007, direct costs for asthma were estimated at $50.1 billion and indirect costs were estimated at $5.9 billion (Figure 38). A recent estimate increased the total annual cost for asthma in the US at $81.9 billion for 2013 from the $56 billion estimate in 2007 (21,22). The annual medical cost of asthma per-person in the US was estimated at $3,266 in 2015 (21).

Figure 38. Estimated Yearly Cost of Asthma, US 2007



Source: Adapted from Asthma and Allergy Foundation of America, May 2015. Available from http://www.aafa.org/page/cost-of-asthma-on-society.aspx.
*Total Annual Cost includes the sum of Direct and Indirect Cost.
†Direct Cost includes costs from medications and hospitalizations.
‡Indirect Cost includes costs from work absenteeism and missed school days.

Healthy People 2020

Healthy People provides national objectives for a 10-year period for improving the health of Americans (23). Healthy People 2020 includes objectives specific to improving asthma-related health. These goals include: reducing the rate of asthma deaths in all age groups, reducing the rate of asthma hospitalizations in all age groups, reducing the rate of ED visits for asthma for all age groups, reducing the proportion of persons with asthma who miss school or work, increasing the proportion of people with current asthma that receive patient education, increasing the proportion of people with current asthma that receive asthma care according to National Asthma Education and Prevention Program guidelines, and increasing the number of states and territories with a comprehensive asthma surveillance system for tracking asthma cases, illness, and disability (24).

Because of small numbers, asthma death rates are not stable when stratified by age group. In general, the number of deaths due to asthma in Kansas increased slightly from 2010 to 2017 (Figure 32). The rate of asthma hospitalizations has decreased for all age groups from 2010 to 2017. The rate of ED visits for asthma has decreased for the 0-4 years old and 65 years and greater age groups from 2010 to 2017, increased for the 5-14 years old age group, and the 15-34 years old and 35-64 years old age groups had similar rates in 2017 as in 2010. Rate changes in asthma hospitalizations and ED visits from 2010 to 2017 should be interpreted with caution due to the change in how hospitals code diagnoses. The US transitioned from ICD-9-CM to ICD-10-CM on October 1, 2015. This coding change may cause a difference in results before 2015 and after 2015 that may not be an actual difference in the number of events. In 2015, the estimated percentage of adults with current asthma that missed days of work or usual activity due to asthma was similar to the 2010 estimate (29.1% and 28.0%, respectively). The percentage of adults with current asthma that received an asthma management plan was similar in 2015 to the 2010 estimate (26.0% and 24.2%, respectively) and the percentage taking an asthma management course was also similar, but slightly lower in 2015 than 2010 (7.7% and 9.5%, respectively). These numbers do not show a significant change. Management plans only occur for about a quarter of adults with asthma and less than one in ten has taken a course on asthma management.

The National Asthma Education and Prevention Program guidelines for asthma have recommendations for the diagnosis of asthma, assessment of asthma, and periodic assessment and monitoring of asthma control for asthma management, asthma self-management education, control of environmental factors and other conditions that affect asthma, and medications (25). Of those guidelines, asthma self-management education and periodic assessment can be described with available data. Asthma self-management education over the 2010-2015 period was previously described. In 2010, an estimated 52.3% of adult Kansans with current asthma had at least one routine doctor visit (26). This estimate did not significantly change for 2015 (53.0%), indicating that for management, education, and periodic assessment there was not an increase in the proportion of people with current asthma that received those aspects of care according to National Asthma Education and Prevention Program guidelines. Kansas does not currently have a comprehensive asthma surveillance system or program for addressing asthma in adults or children. Available data suggest that Kansas is not currently on track to meet all Healthy People 2020 goals for asthma.

Conclusions

This report has outlined the prevalence, health care utilization, and mortality from asthma in Kansas. While the overall prevalence of current asthma in adults is lower in Kansas than much of the US, BRFSS data indicate that certain populations in Kansas may be at a greater risk for developing asthma than others. These higher risk populations include male children, female adults, people living in low-income households, those that are black or African American, and those that claim more than one race.

Although there are few asthma deaths in Kansas each year, those that do occur can be decreased in number with proper asthma control. There are thousands of ED visits and hospitalizations from asthma each year in Kansas. These visits are costly, but better asthma management can help reduce their number. These visits can also be used as an opportunity to provide education on proper asthma management. While managing asthma is important for reducing the burden of asthma, only about one-fourth of adults with current asthma in Kansas received an asthma management plan. To successfully manage asthma, individuals with asthma and their household members need to receive education and the tools for proper asthma treatment and to control their environment to avoid their asthma triggers.

Young children, particularly males, have higher rates of asthma ED visits and hospitalizations, making them a vulnerable group. Because of this, asthma management plans and educational information that has been shared with families of children with asthma should also be shared with childcare centers, schools, and other places where children spend time.

Those that report their race as something other than white have higher rates of asthma ED visits and hospitalizations, making them a vulnerable group. Asthma patients that are at a higher risk should be given the knowledge and tools to control their asthma, such as an asthma management plan. Additionally, culturally competent outreach and education materials should be developed and used. Finally, physician-patient communication is an important factor in preventing and managing asthma episodes.

Appendix A: Data Sources

Behavioral Risk Factor Surveillance System (BRFSS)
The Kansas Behavioral Risk Factor Surveillance System (BRFSS) is an annual telephone survey that is conducted from a random sample of Kansas household resident adults. The Kansas BRFSS is part of the national BRFSS, which is a state-based survey conducted by state health departments (6). Data is collected monthly using a standardized questionnaire that includes standard core questions, rotating core questions, optional question modules, and state-added questions (6). Data weighting is then done to attempt to remove bias from the sample population. The BRFSS weighting includes design weighting and iterative proportional fitting weighting; further details about the BRFSS data weighting process can be found in The BRFSS Data User Guide (6). The standard core questions have included questions about asthma since 1999; respondents that reported that they were ever diagnosed with asthma may be further contacted for the asthma call-back survey, which was implemented in 2006 (26). The asthma call-back survey is used to further assess the health and experiences of those that have asthma. Adults and children who have lifetime asthma, as identified by BRFSS, are asked more in-depth questions about their asthma history which may include symptoms, medication use, healthcare utilization, asthma management, household exposures, and work-related asthma.

The BRFSS survey methodology was altered in 2011 to include landline telephone and mobile phone users for surveys. Weighting methodology was also changed to adjust for differences in respondent and target demographics at this time. Because of this, BRFSS estimates from 2011 and after cannot be accurately compared to years prior. The BRFSS only represents the non-institutionalized civilian population that has access to a telephone. Survey answers are self-reported by respondents and may be influenced by recall bias.

Emergency Department (ED) Visits
ED visit data were obtained through the Kansas Hospital Association. Admission records for asthma were selected using the primary discharge diagnosis code. ED visit records prior to October 1, 2015, were represented by ICD-9-CM diagnosis code 493. Visit records as of October 1, 2015, were represented by ICD-10-CM code J45. Non-Kansas residents were excluded from the dataset. ED visits to federal facilities and visits of Kansas residents to out-of-state hospitals were not included in the dataset. For years 2011-2017, denominators for rates used the United States Census Bureau's first postcensal bridged-race population estimate for the vintage year by sex. Bridged-race population estimates for 2010 are based on the April 1 actual census counts. Age-adjusted rates were calculated by the direct method using the 2000 US standard population.

Hospital Inpatient Visits
Inpatient hospitalization data were obtained through the Kansas Hospital Association. Admission records for asthma were selected using the primary discharge diagnosis code. Hospital admission records prior to October 1, 2015, were represented by ICD-9-CM diagnosis code 493. Admission records as of October 1, 2015, were represented by ICD-10-CM code J45. Non-Kansas residents were excluded from the dataset. Hospital admissions to federal facilities and admissions of Kansas residents to out-of-state hospitals were not included in the dataset. For years 2000-2009, denominators for rates use 2000 to 2009 bridged-race intercensal population estimates. For years 2011-2017, denominators for rates used the United States Census Bureau's first postcensal bridged-race population estimate for the vintage year by sex.

Bridged-race population estimates for 2010 are based on the April 1 actual census counts. Age-adjusted rates were calculated by the direct method using the 2000 US standard population.

Mortality

National mortality data are obtained from The National Vital Statistics System (NVSS). Kansas mortality data are obtained from the Kansas Department of Health and Environment Bureau of Epidemiology and Public Health Informatics. Asthma deaths are determined using deaths with ICD-10-CM code J45-J46 as the underlying cause of death during a calendar year. Asthma mortality rate is calculated using the number of asthma deaths in a calendar year as the numerator and the midyear resident population for the same calendar year as the denominator (27). Denominator data are from the US Census Bureau. Relative standard error (RSE) was calculated to determine statistical reliability. For mortality rates, RSE is equal to $1 \div \sqrt{cases}$. An RSE of greater than 30% is considered statistically unreliable; these rates were flagged with an asterisk as unstable.

Medicaid

Medicaid is a program that provides health care coverage to low-income children and adults. Persistent asthma using the Healthcare Effectiveness Data and Information Set (HEDIS) definition was used to define asthma in the Medicaid population. Individuals with persistent asthma were those fulfilling at least one of four criteria during the past year: 1) one or more ED visits for asthma, 2) one or more hospitalization with asthma as the principal diagnosis, 3) at least four outpatient visits with asthma as the principal diagnosis and two or more asthma medication-dispensing events, or 4) four or more asthma medication-dispensing events. The HEDIS persistent asthma definition was extended to include individuals that were under 5 years old. Medicaid data was obtained through the Kansas Department of Health and Environment, Division of Health Care Finance. Data included the total number of individuals enrolled in Medicaid by age and sex and the total number of individuals enrolled meeting the HEDIS persistent asthma definition by age and sex. ED visit and hospital admission records prior to October 1, 2015, were represented by ICD-9-CM diagnosis code 493. ED visit and hospital admission records as of October 1, 2015, were represented by ICD-10-CM code J45.

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