Epidemiology of Asthma

In Kalamazoo County, Michigan

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Not Included: Asthma Mortality

Due to the low number of deaths for the population of Kalamazoo County, asthma mortality rates are not available and therefore are excluded from this report.

Section 1: Asthma Prevalence

Prevalence is the proportion of individuals in a population who have the disease at a point in time or during a given time period. It is often used to describe the health burden on a given population. Using prevalence estimates of current asthma from the Michigan Behavioral Risk Factor Survey (BRFS), estimates of the number with asthma living in each county are given in this section.

Current asthma prevalence is the proportion of survey respondents who reported that in their lifetime a health care professional told them they have asthma and reported "yes" to the question: Do you still have asthma?

The Michigan BRFS is the source of most estimates of the prevalence of certain health behaviors, conditions, and practices associated with leading causes of death. Data are collected quarterly by telephone interview; a sample of telephone numbers is selected using a list-assisted, random-digit dialed methodology.

From this survey, the prevalence of asthma can be determined for adults (≥ 18 years) and children (< 18 years). Data for children are based on information provided by an adult respondent about children living in their home. Due to small sample size, descriptive information regarding children is limited, precluding prevalence analysis by age, race, and sex strata.

Data from the BRFS are designed to estimate prevalence statewide. However, using asthma prevalence for the State of Michigan, we can approximate the number of individuals with asthma in specific counties and local coalitions. In this report, the number of adults (≥18 years) with asthma was calculated using the asthma prevalence rates from the 2003 Michigan Behavioral Risk Factor Survey. The number of children with asthma was calculated from the prevalence rates reported in the 2002 Michigan Behavioral Risk Factor Survey.

Number of Children (aged less than 18 years) [1] and Adults (aged 18 years and older) [2] with Asthma in Kalamazoo County and the State of Michigan.

	Children (<18 Years)	Adults (≥18 Years)
	2002	2003
Kalamazoo County	5,238	17,191
Michigan	233,894	701,319

1 Number of children with current asthma was calculated by multiplying the population of children in 2002 by the percentage of adults reporting current asthma for children in the home in the 2002 Michigan BRFS.

2 Number of adults with current asthma was calculated by multiplying the population of adults in 2003 by the percentage reporting current asthma in the 2003 Michigan BRFS.

Data Source: Behavioral Risk Factor Survey, Michigan, 2002 and 2003

Section 2: Hospitalization for Asthma

Preventable hospitalizations are those where timely and effective ambulatory care can prevent the onset of an illness or condition, control an acute episode of an illness, or manage a chronic disease or condition so that hospitalization is unnecessary. Asthma hospitalizations are considered preventable because patients with asthma should be able to stay out of the hospital if they have and use good asthma management techniques.

Hospitalization data was acquired from the Michigan Inpatient Database for the years 1990 to 2002. All hospital discharges from any of Michigan's reporting acute care hospitals or Michigan residents discharged from reporting acute care hospitals in contiguous states are included in this database. It includes virtually all hospitalizations in Michigan and for Michigan residents during this time period.

There is no confirmed case classification for an asthma hospitalization. In accordance with the case definition for a probable asthma hospitalization recommended by the Council for State and Territorial Epidemiologists (CSTE), all inpatient hospitalizations are selected from the database where asthma was the primary reason for the stay. (Position Statement 1998-EH/CD1) These are hospitalizations with primary discharge diagnosis coded to the International Classification of Disease (ICD) Version-9-CM codes 493.XX.

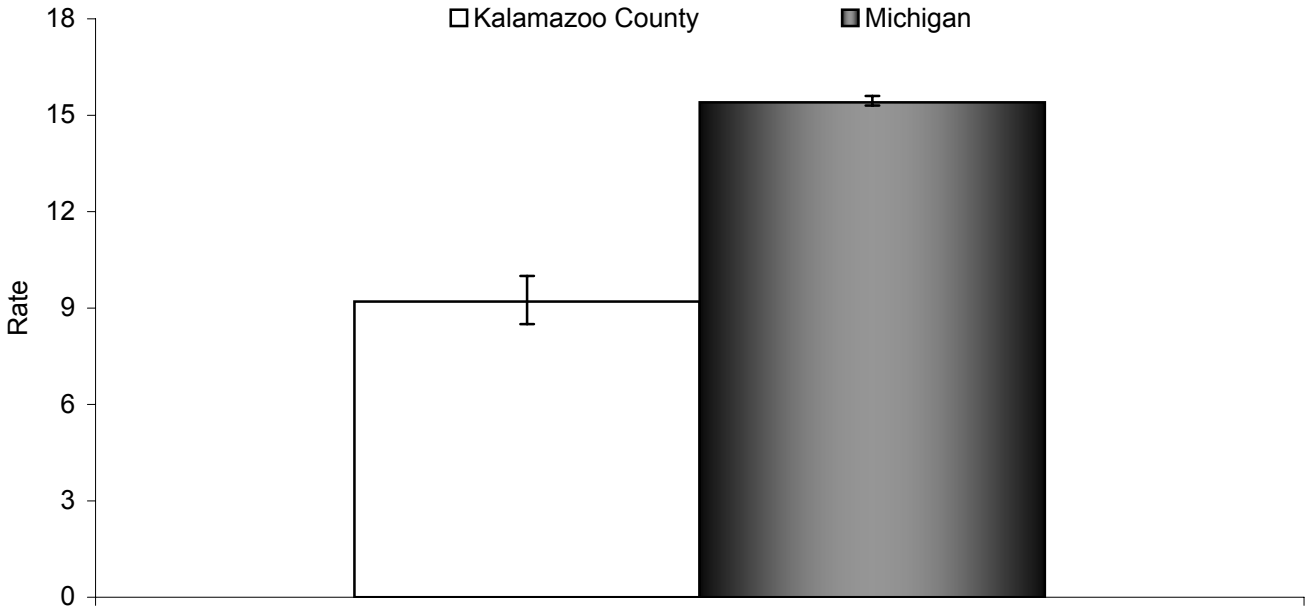
These data are the number of inpatient hospitalizations for asthma. This is not the same as the number of individual people hospitalized for asthma. An individual can be hospitalized more than once for the same condition during the study period and multiple hospitalizations cannot be distinguished from this data source. From these data, age-adjusted asthma hospitalization rates are calculated and presented per 10,000 population. Rates are age adjusted so that valid comparisons can be made between populations of different age distributions.

Hospitalization rates for demographic or geographic units with a small number of events (less than or equal to 20 events) or a small population size (less than 5,000 population) are not calculated because these rates are statistically unstable. In addition, to protect the identity of persons who have been hospitalized, counts less than 5 are not presented in this report.

Ninety five percent confidence intervals are computed for hospitalization rates where more than one year of data are combined. The confidence interval estimates the statistical uncertainty of the asthma hospitalization rate and can be used to test whether a specific measure is statistically different between groups. Average asthma hospitalization rates are considered statistically different between groups if their 95% confidence intervals do not overlap. This technique is used to compare rates for demographic subpopulations, such as male versus female, and geographical subpopulations, such as county versus state.

To determine if annual asthma hospitalization rates follow an increasing or decreasing trend over the 13-year period 1990-2002, the Spearman Correlation Coefficient and its accompanying statistical Rank Correlation Test are utilized. This test assesses whether there is a statistically significant monotonic relationship between 2 variables, in this case year and asthma hospitalization rate, without making any assumption about the underlying distribution of the data. This statistical test does not determine the significance of more complex trend patterns. There is no way to know from these statistics if a specific event or series of events caused a change in asthma hospitalization rates.

Figure 1. Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] for Kalamazoo County and the State of Michigan, All Ages, 2000-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 2001.

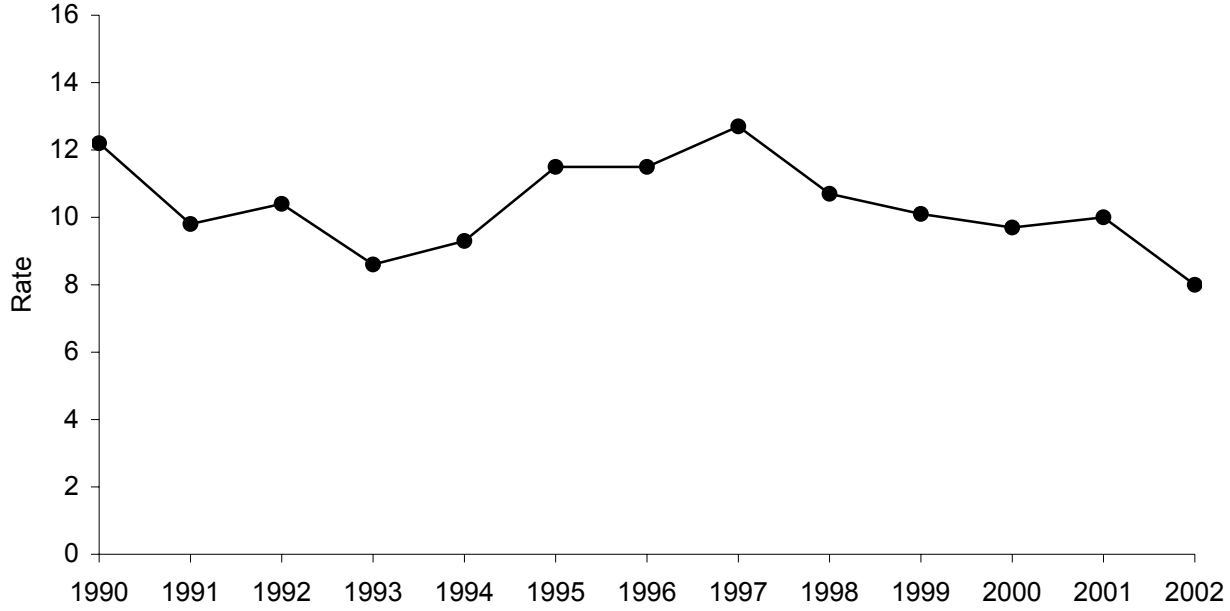
3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	Total Population
Kalamazoo County Rate	9.2
95% CI	8.5 , 10.0
Count	631
Michigan Rate	15.4
95% CI	15.3 , 15.6
Count	45,945

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

- The average number of hospitalizations due to asthma per year in Kalamazoo County, 2000-2002, is 210.
- Kalamazoo County has significantly lower asthma hospitalization rates than the State of Michigan as a whole, 2000-2002.

Figure 2. Annual Rates (per 10,000) [1,2] of Asthma [3] Hospitalization, All Ages, for Kalamazoo County, 1990-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 1990-2002.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

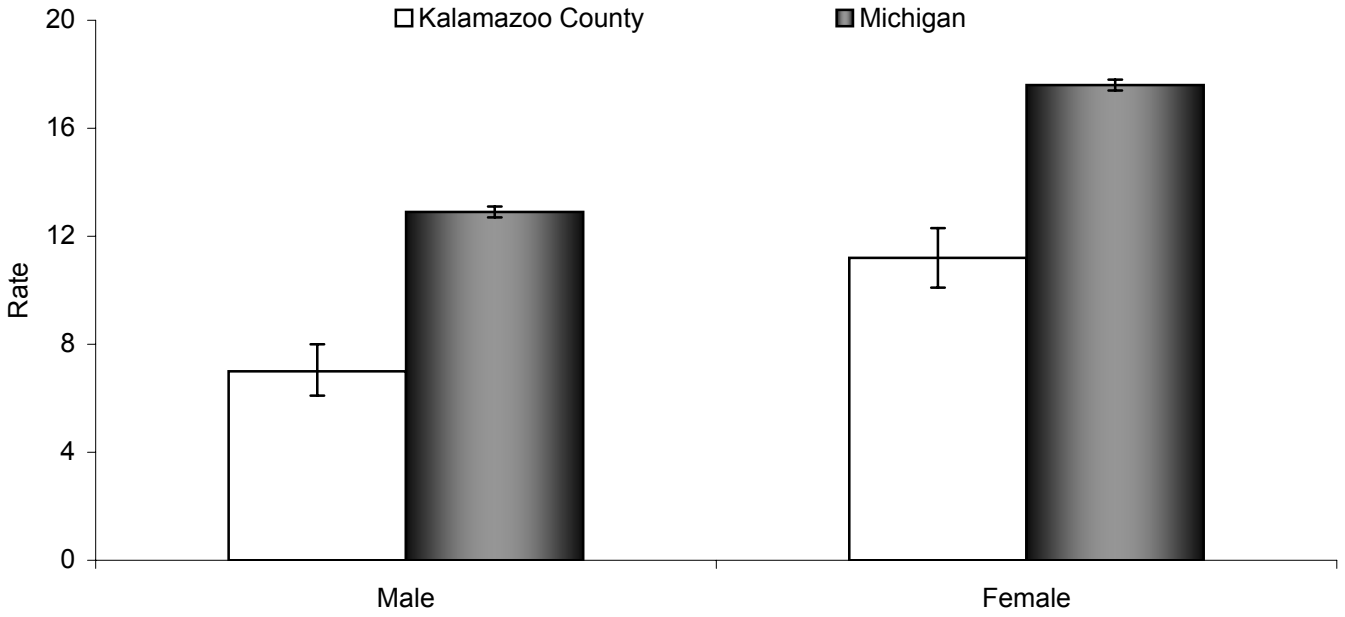
	Total Population	
Year	Rate	Count
1990	12.2	272
1991	9.8	216
1992	10.4	235
1993	8.6	198
1994	9.3	210
1995	11.5	262
1996	11.5	258
1997	12.7	293
1998	10.7	248
1999	10.1	232
2000	9.7	219
2001	10.0	226
2002	8.0	186

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ Between 1990 and 2002, there has not been a significant trend in asthma hospitalization rates for the total population in Kalamazoo County.

See appendix page 28 for supporting data.

Figure 3. Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] by Sex for Kalamazoo County and the State of Michigan, All Ages, 2000-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 2001.

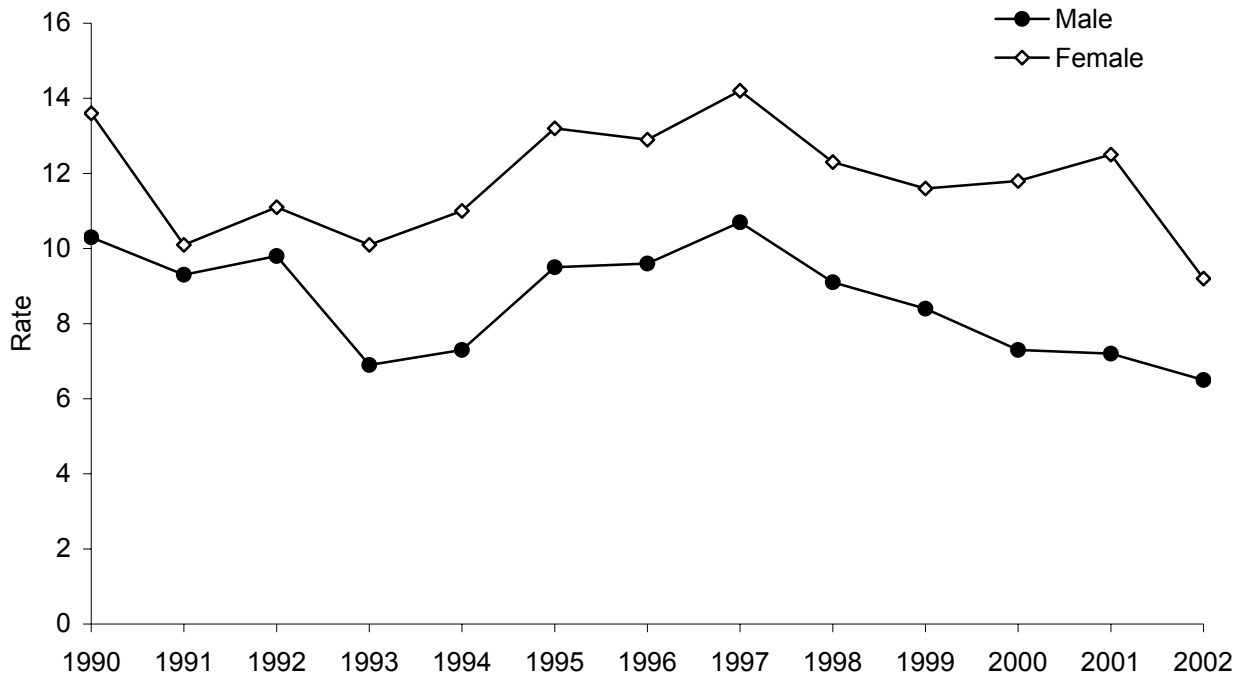
3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	Male	**Female**
Kalamazoo County Rate	7.0	11.2
95% CI	6.1 , 8.0	10.1 , 12.3
Count	231	400
Michigan Rate	12.9	17.6
95% CI	12.7 , 13.1	17.4 , 17.8
Count	18,987	26,958

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

- ✧ The asthma hospitalization rates for males and females in Kalamazoo County are significantly lower than the respective rates for the State of Michigan as a whole, 2000-2002.
- ✧ In Kalamazoo County and the State of Michigan, females have significantly higher asthma hospitalization rates than males, 2000-2002.

Figure 4. Annual Rates (per 10,000) [1,2] of Asthma [3] Hospitalization by Sex, All Ages, for Kalamazoo County, 1990-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 1990-2002.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

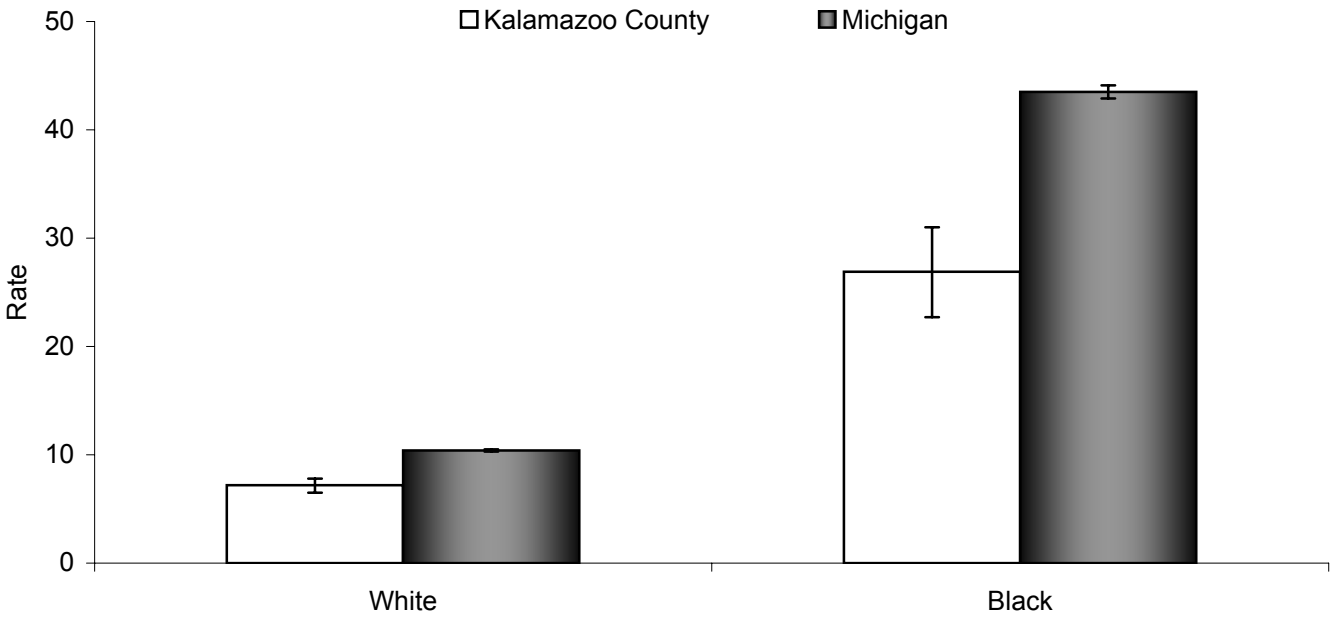
	Male		**Female**	
Year	Rate	Count	Rate	Count
1990	10.3	121	13.6	151
1991	9.3	99	10.1	117
1992	9.8	109	11.1	126
1993	6.9	80	10.1	118
1994	7.3	83	11.0	127
1995	9.5	109	13.2	153
1996	9.6	107	12.9	151
1997	10.7	124	14.2	169
1998	9.1	101	12.3	147
1999	8.4	93	11.6	139
2000	7.3	80	11.8	139
2001	7.2	77	12.5	149
2002	6.5	74	9.2	112

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ Between 1990 and 2002, there has not been a significant trend in asthma hospitalization rates for the male or female population in Kalamazoo County.

See appendix pages 29 and 30 for supporting data.

Figure 5. Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] by Race [4] for Kalamazoo County and the State of Michigan, All Ages, 2000-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 2001.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

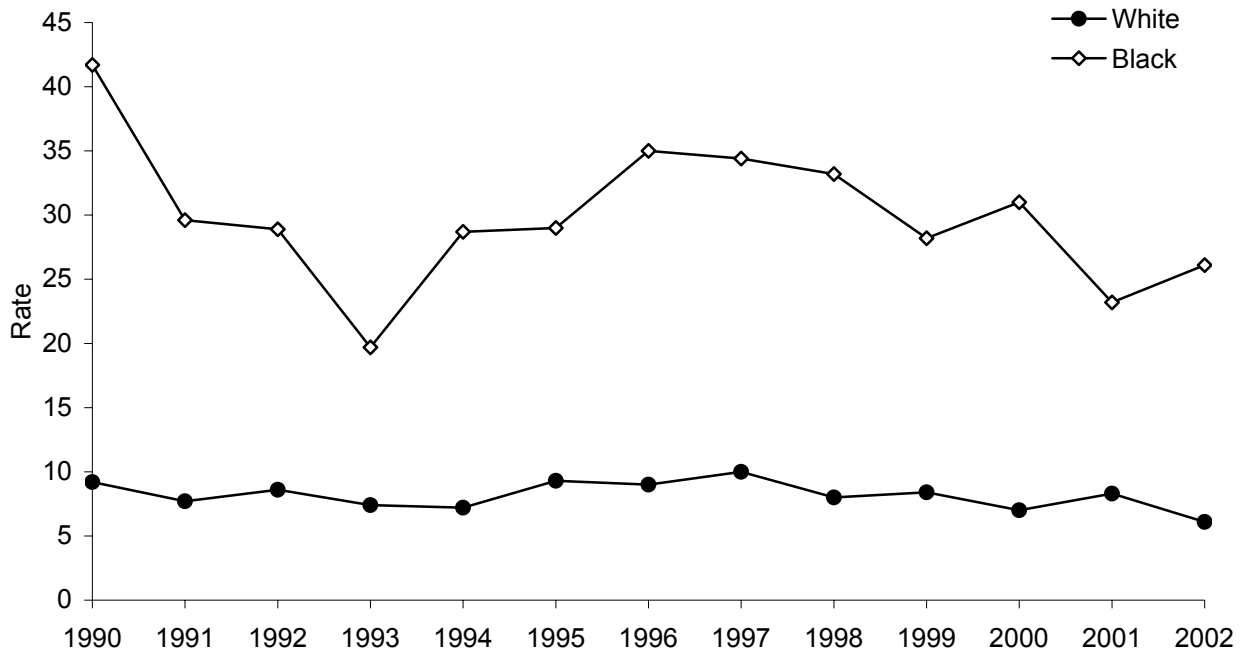
4 For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

	White	Black
Kalamazoo County Rate	7.2	26.9
95% CI	6.5 , 7.8	22.7 , 31.0
Count	418	198
Michigan Rate	10.4	43.5
95% CI	10.3 , 10.5	42.9 , 44.1
Count	25,455	19,685

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

- The asthma hospitalization rates for both white persons and black persons in Kalamazoo County are significantly lower than the respective rates for the State of Michigan as a whole, 2000-2002.
- The asthma hospitalization rates for white persons in Kalamazoo County and the State of Michigan are significantly lower than the respective rates for black persons, 2000-2002.
- While black persons in Kalamazoo County and the State of Michigan have higher asthma hospitalization rates, white persons experience the greatest absolute burden of asthma hospitalization.

Figure 6. Annual Rates (per 10,000) [1,2] of Asthma [3] Hospitalization by Race [4], All Ages, for Kalamazoo County, 1990-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 1990-2002.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

4 For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

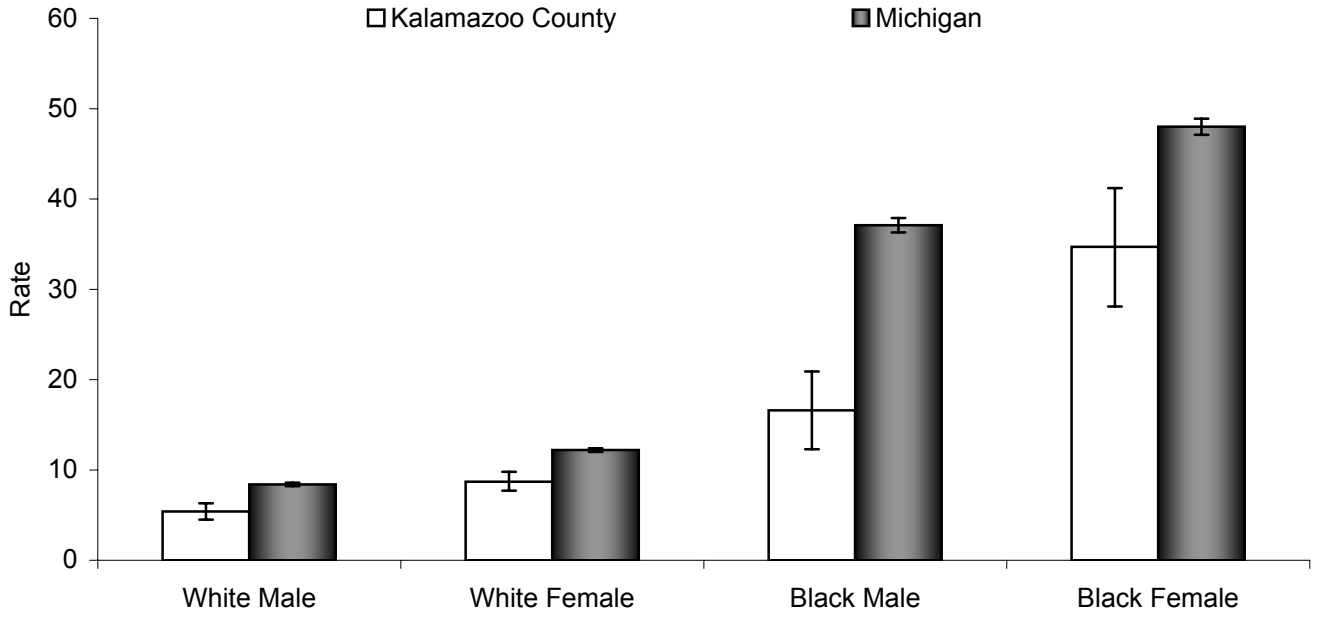
	White		Black	
Year	Rate	Count	Rate	Count
1990	9.2	176	41.7	96
1991	7.7	149	29.6	67
1992	8.6	168	28.9	62
1993	7.4	145	19.7	52
1994	7.2	139	28.7	68
1995	9.3	180	29.0	73
1996	9.0	174	35.0	81
1997	10.0	195	34.4	95
1998	8.0	157	33.2	84
1999	8.4	161	28.2	69
2000	7.0	135	31.0	80
2001	8.3	164	23.2	57
2002	6.1	119	26.1	61

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ Between 1990 and 2002, there has not been a significant trend in asthma hospitalization rates for white persons or black persons in Kalamazoo County.

See appendix pages 31 and 32 for supporting data.

Figure 7. Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] by Sex and Race [4] for Kalamazoo County and the State of Michigan, All Ages, 2000-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 2001.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

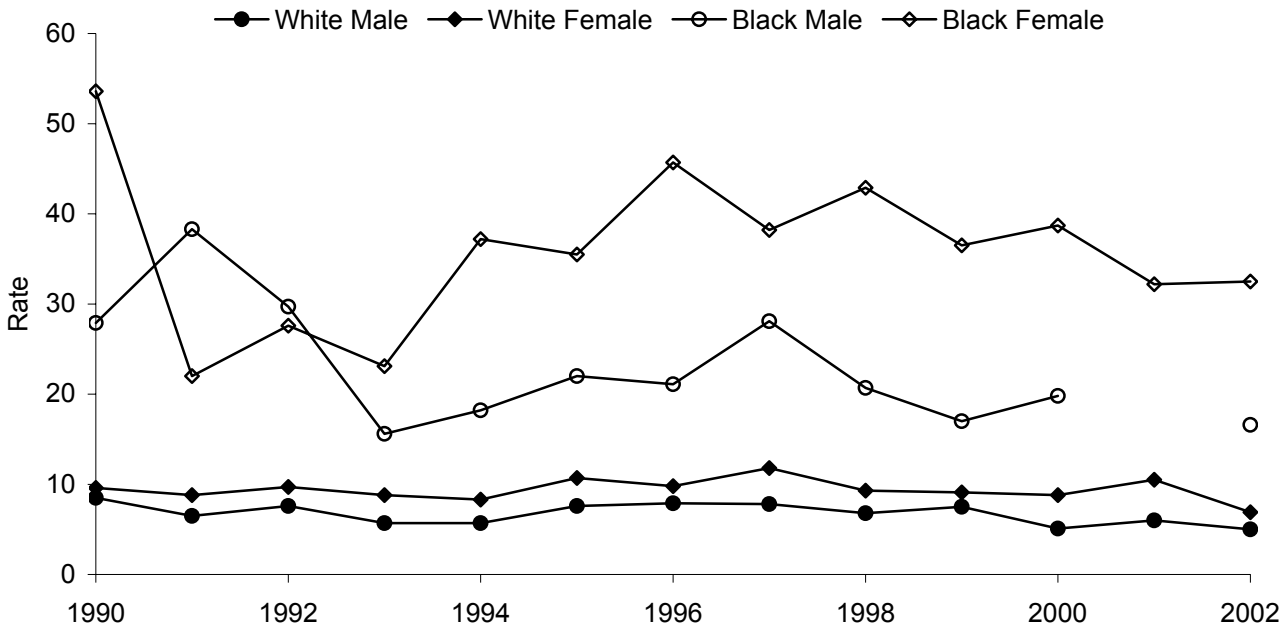
4 For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

	White Male	White Female	Black Male	Black Female
Kalamazoo County Rate	5.4	8.7	16.6	34.7
95% CI	4.5 , 6.3	7.7 , 9.8	12.3 , 20.9	28.1 , 41.2
Count	146	272	77	121
Michigan Rate	8.4	12.2	37.1	48.0
95% CI	8.2 , 8.6	12.0 , 12.4	36.3 , 37.9	47.1 , 48.9
Count	9,916	15,539	8,702	10,983

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

- The asthma hospitalization rate for black females in Kalamazoo County is significantly higher than the rates among white males, white females, or black males in Kalamazoo County, 2000-2002.
- The asthma hospitalization rate for black persons in Kalamazoo County is significantly higher than the rate among white persons in Kalamazoo County, 2000-2002, regardless of sex.
- The asthma hospitalization rates for all race/sex strata in Kalamazoo County are significantly lower than respective rates for the State of Michigan as a whole, 2000-2002.

Figure 8. Annual Rates (per 10,000) [1,2] of Asthma [3] Hospitalization by Sex and Race [4], All Ages, for Kalamazoo County, 1990-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 1990-2002.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

4 For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

	White Male		White Female		Black Male		Black Female	
Year	Rate	Count	Rate	Count	Rate	Count	Rate	Count
1990	8.5	83	9.6	93	27.9	38	53.6	58
1991	6.5	58	8.8	91	38.3	41	22.0	26
1992	7.6	71	9.7	97	29.7	35	27.6	27
1993	5.7	55	8.8	90	15.6	24	23.1	28
1994	5.7	55	8.3	84	18.2	26	37.2	42
1995	7.6	72	10.7	108	22.0	33	35.5	40
1996	7.9	73	9.8	101	21.1	33	45.7	48
1997	7.8	74	11.8	121	28.1	49	38.2	46
1998	6.8	62	9.3	95	20.7	35	42.9	49
1999	7.5	69	9.1	92	17.0	24	36.5	45
2000	5.1	45	8.8	90	19.8	34	38.7	46
2001	6.0	54	10.5	110	‡	19	32.2	38
2002	5.0	47	6.9	72	16.6	24	32.5	37

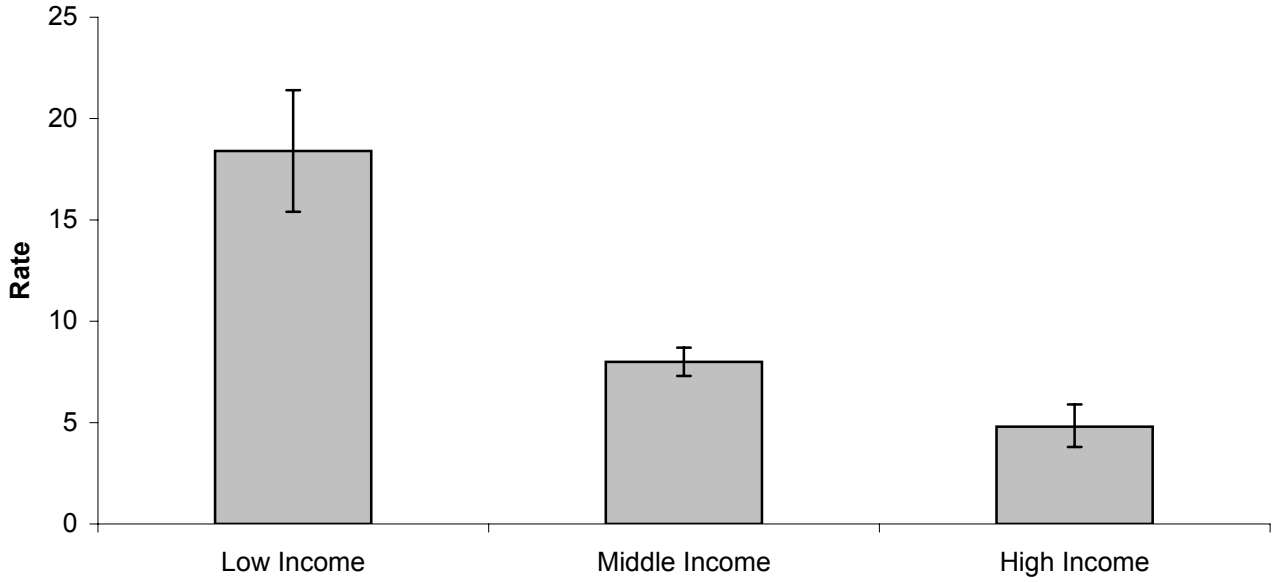
‡ Insufficient data to compute a stable rate (number of events ≤20 or population <5000).

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ Between 1990 and 2002, there has not been a significant trend in asthma hospitalization rates for any of the race/sex strata in Kalamazoo County.

See appendix pages 33 through 36 for supporting data.

Figure 9. Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] by Income [4] for Kalamazoo County, 2000-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Populations are taken from the 2000 US Census.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

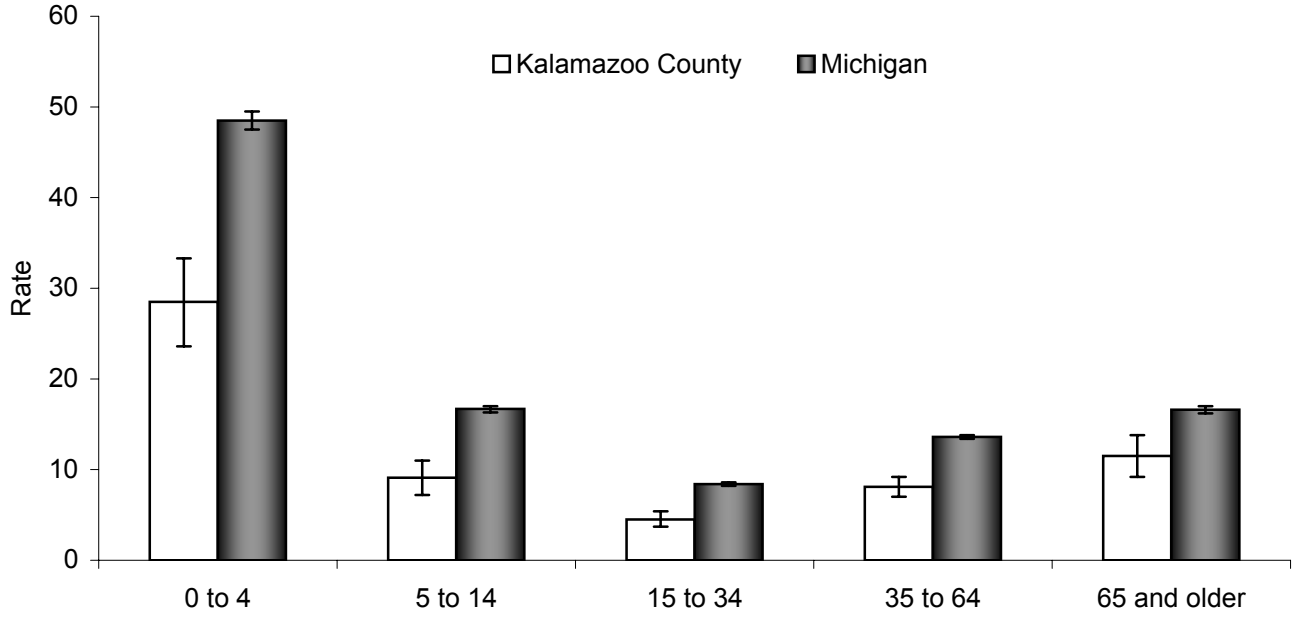
4 High income = top 20% of Michigan's zip code areas, as determined by median household income from Census 2000; Low income = bottom 20% of Michigan's zip code areas, as determined by median household income from Census 2000; all others are considered middl

	Low Income	Medium Income	High Income
Kalamazoo County Rate	18.4	8.0	4.8
95% CI	15.4 , 21.4	7.3 , 8.7	3.8 , 5.9
Count	154	497	79

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ The asthma hospitalization rate for low income areas in Kalamazoo County is significantly higher than the rate for high or middle income areas in Kalamazoo County, 2000-2002.

Figure 10. Rates (per 10,000) [1] of Hospitalization due to Asthma [2] by Age Group for Kalamazoo County and the State of Michigan, 2000-2002.



1 Population estimates are taken from the Michigan population estimates for 2001.

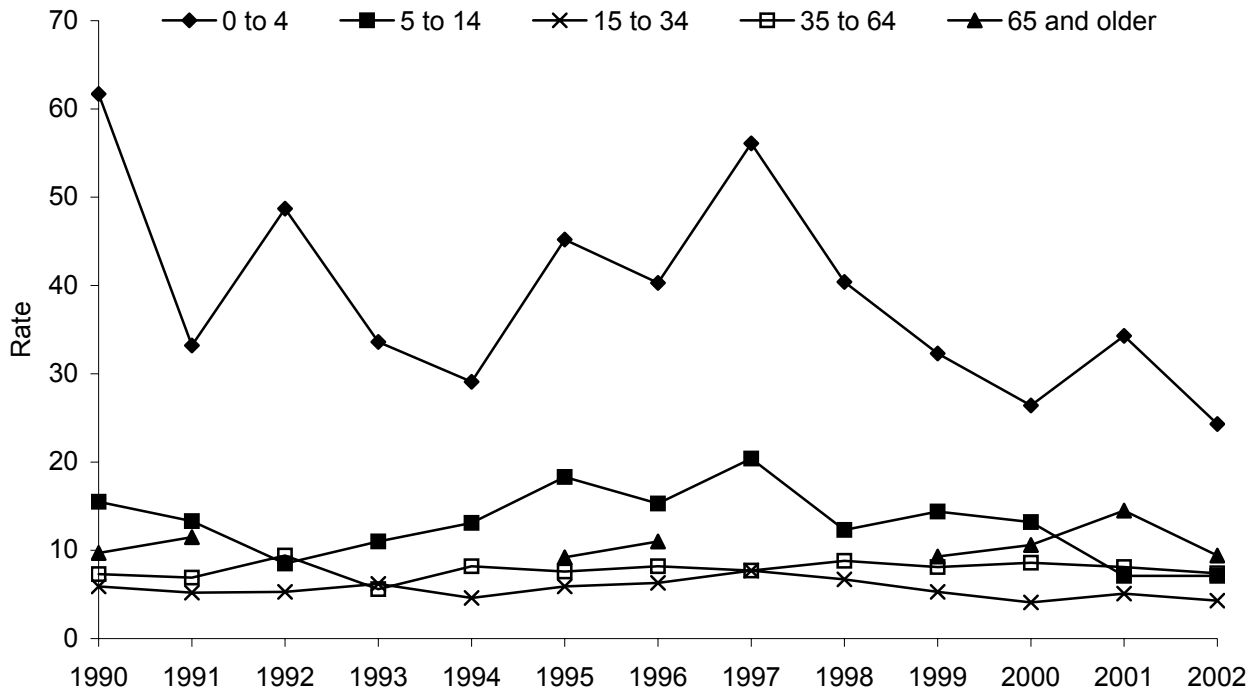
2 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	0 to 4	5 to 14	15 to 34	35 to 64	65 and older
Kalamazoo County Rate	28.5	9.1	4.5	8.1	11.5
95% CI	23.6 , 33.3	7.2 , 11.0	3.7 , 5.4	7.0 , 9.2	9.2 , 13.8
Count	132	89	106	209	95
Michigan Rate	48.5	16.7	8.4	13.6	16.6
95% CI	47.5 , 49.5	16.3 , 17.0	8.2 , 8.6	13.4 , 13.8	16.2 , 17.0
Count	9,637	7,375	6,859	15,964	6,110

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

- For Kalamazoo County and the State of Michigan, children aged 0 to 4 years have significantly higher rates of asthma hospitalization than all other age groups, 2000-2002.
- For Kalamazoo County and the State of Michigan, persons aged 15 to 34 years have significantly lower rates of asthma hospitalization than all other age groups, 2000-2002.
- The asthma hospitalization rates for all age groups in Kalamazoo County are significantly lower than respective rates for the State of Michigan as a whole, 2000-2002.

Figure 11. Annual Rates (per 10,000) [1] of Asthma [2] Hospitalization by Age Group for Kalamazoo County, 1990-2002.



1 Population estimates are taken from the Michigan population estimates for 1990-2002.

2 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	0 to 4		5 to 14		15 to 34		35 to 64		65 and older	
Year	Rate	Count	Rate	Count	Rate	Count	Rate	Count	Rate	Count
1990	61.7	102	15.5	46	5.9	48	7.3	53	9.7	23
1991	33.2	55	13.3	40	5.2	42	6.9	51	11.5	28
1992	48.7	81	8.5	26	5.3	42	9.4	71	‡	15
1993	33.6	56	11.0	34	6.2	49	5.6	43	‡	16
1994	29.1	48	13.1	41	4.6	36	8.2	65	‡	20
1995	45.2	73	18.3	58	5.9	46	7.6	61	9.2	24
1996	40.3	64	15.3	49	6.3	49	8.2	67	11.0	29
1997	56.1	88	20.4	66	7.7	60	7.7	64	‡	15
1998	40.4	63	12.3	40	6.7	52	8.8	74	‡	19
1999	32.3	50	14.4	47	5.3	41	8.1	69	9.3	25
2000	26.4	41	13.2	43	4.1	32	8.6	74	10.6	29
2001	34.3	53	7.1	23	5.1	40	8.1	70	14.5	40
2002	24.3	38	7.1	23	4.3	34	7.4	65	9.4	26

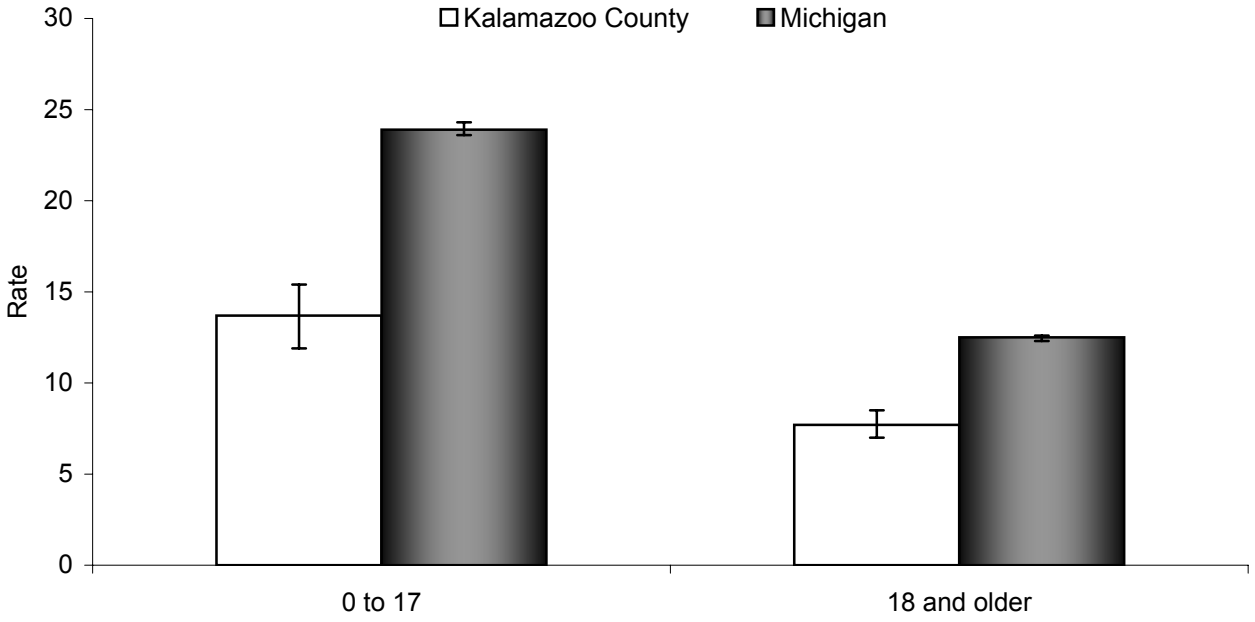
‡ Insufficient data to compute a stable rate (number of events ≤20 or population <5000).

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ Between 1990 and 2002, there has not been a significant trend in asthma hospitalization rates for any age group in Kalamazoo County.

See appendix pages 37 through 41 for supporting data.

Figure 12. Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] by Age Group for Kalamazoo County and the State of Michigan, 2000-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 2001.

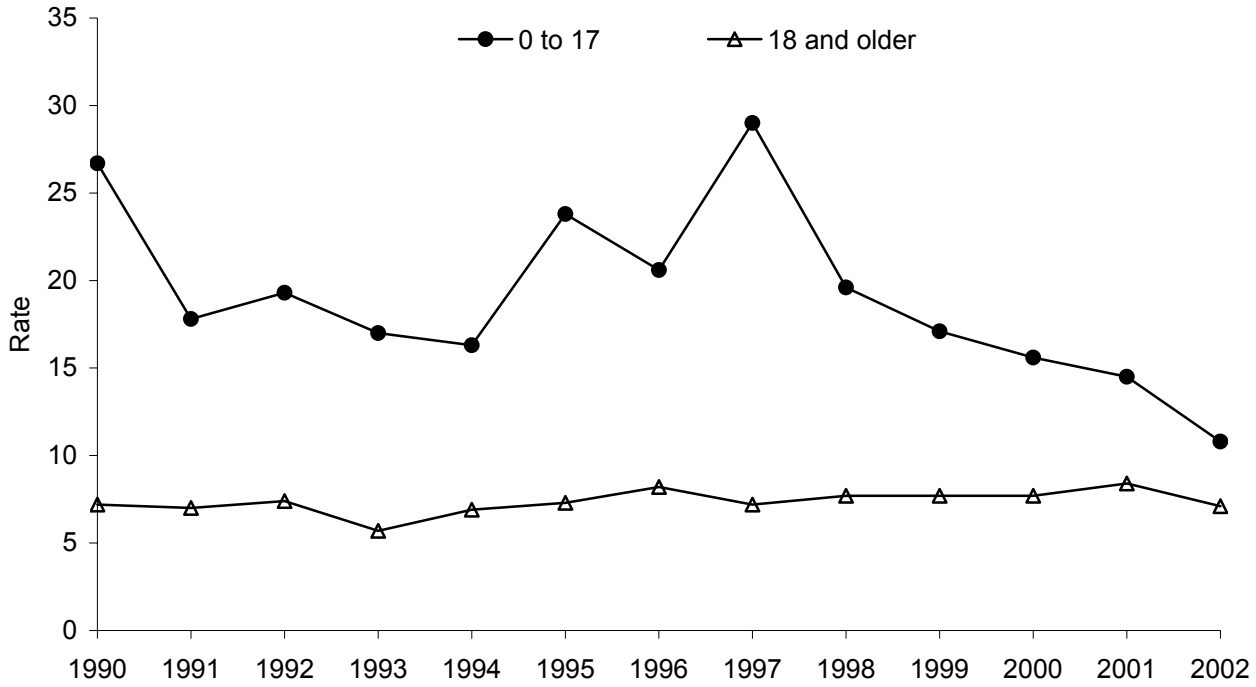
3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	0 to 17	**18 and Older**
Kalamazoo County Rate	13.7	7.7
95% CI	11.9 , 15.4	7.0 , 8.5
Count	235	396
Michigan Rate	23.9	12.5
95% CI	23.6 , 24.3	12.3 , 12.6
Count	18,141	27,804

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

- ✧ The rates of asthma hospitalization for children less than 18 years of age and adults aged 18 years and older in Kalamazoo County are significantly lower than the respective rates for the State of Michigan as a whole, 2000-2002.
- ✧ For Kalamazoo County and the State of Michigan, the rates of asthma hospitalization for children less than 18 years of age are significantly higher than that for adults aged 18 years and older, 2000-2002.

Figure 13. Annual Rates (per 10,000) [1,2] of Asthma [3] Hospitalization by Age Group for Kalamazoo County, 1990-2002.



1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 1990-2002.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	0 to 17		18 and Older	
Year	Rate	Count	Rate	Count
1990	26.7	155	7.2	117
1991	17.8	102	7.0	114
1992	19.3	114	7.4	121
1993	17.0	99	5.7	99
1994	16.3	95	6.9	115
1995	23.8	139	7.3	123
1996	20.6	119	8.2	139
1997	29.0	168	7.2	125
1998	19.6	113	7.7	135
1999	17.1	99	7.7	133
2000	15.6	90	7.7	129
2001	14.5	83	8.4	143
2002	10.8	62	7.1	124

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ Between 1990 and 2002, there has not been a significant trend in asthma hospitalization rates for either age group in Kalamazoo County.

See appendix pages 42 and 43 for supporting data.

Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] by Zip Code of Residence, Kalamazoo County, All Ages, 2000-2002.

			95% Confidence Interval	
Zip Code	Count	Rate	Lower Limit	Upper Limit
49001	137	11.4	9.5	13.3
49002	32	5.7	3.7	7.6
49004	49	7.6	5.4	9.7
49006	46	8.6	6.0	11.2
49007	108	36.5	29.4	43.7
49008	31	7.6	4.8	10.4
49009	65	7.6	5.7	9.5
49012	6	‡	‡	‡
49015	84	8.2	6.5	10.0
49024	36	4.3	2.9	5.8
49034	7	‡	‡	‡
49052	~	‡	‡	‡
49053	16	‡	‡	‡
49060	~	‡	‡	‡
49071	14	‡	‡	‡
49078	14	‡	‡	‡
49080	52	12.2	8.9	15.5
49083	9	‡	‡	‡
49087	12	‡	‡	‡
49088	~	‡	‡	‡
49097	9	‡	‡	‡
Kalamazoo County	**631**	**9.2**	**8.5**	**10.0**

1 Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Populations are taken from the 2000 US Census.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

‡ Insufficient data to compute a stable rate (number of events ≤20 or population <5000).

~ Number of hospitalizations <5.

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

Section 3: *Healthy People 2010* Objectives for Asthma

The U.S. Department of Health and Human Services has developed *Healthy People 2010*, a set of disease prevention and health promotion objectives for the nation to achieve over the first decade of the new century. Although neither the United States nor Michigan have met all the *Healthy People 2010* targets for asthma, Michigan has had some success in reaching particular asthma objectives for some populations. For more information about the *Healthy People 2010* initiative, visit their website: http://www.healthypeople.gov.

The following asthma hospitalization figures provide information for Kalamazoo County and the State of Michigan, as compared to the *Healthy People 2010* targets for asthma.

Selected *Healthy People 2010* Objectives Related to Asthma for which Kalamazoo County Data are Available for Comparison.

Objective 1-9a: Reduce hospitalization rates for three ambulatory-care-sensitive conditions: pediatric asthma, uncontrolled diabetes, and immunization preventable pneumonia and influenza.

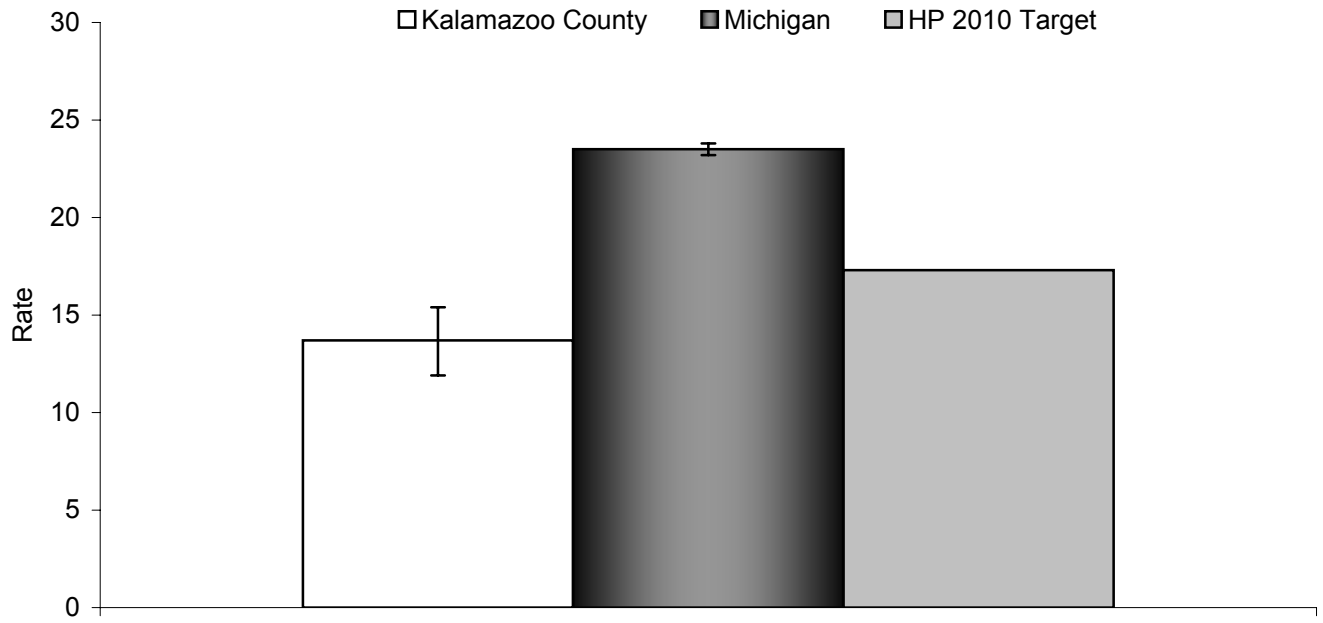
Target: 17.3 per 10,000 (age 0-17 years)

Objective 24-2: Reduce hospitalizations for asthma.

Targets: 25 per 10,000 (age 0-4 years)
7.7 per 10,000 (age 5-64 years*)
11 per 10,000 (age ≥65 years*)

*Age adjusted to the 2000 U.S. standard population.

Figure 14. Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] for Children (aged less than 18 years) in Kalamazoo County and the State of Michigan, 2000-2002, Compared to the Healthy People 2010 Target (Objective 1-9a).



1 Population estimates are taken from the Michigan population estimates for 2001.

2 Not age adjusted in accordance with analysis prescribed by Healthy People 2010 Objectives.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

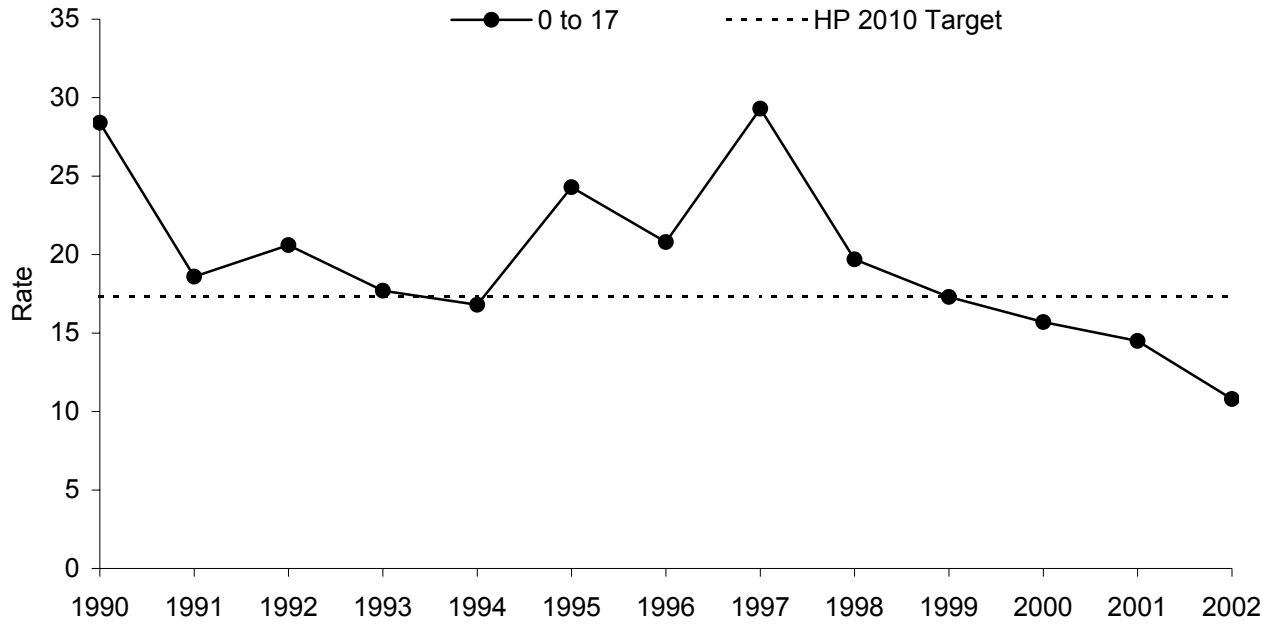
	Total Population
Kalamazoo County Rate	13.7
95% CI	11.9 , 15.4
Count	235
Michigan Rate	23.5
95% CI	23.2 , 23.8
Count	18,141

HP 2010 Target	**17.3**

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

- The average number of hospitalizations due to asthma per year for children aged less than 18 years in Kalamazoo County, 2000-2002, is 78.
- The rate of asthma hospitalization for children aged less than 18 years in Kalamazoo County, 2000-2002, is significantly lower than the *Healthy People 2010* objective.

Figure 15. Annual Rates (per 10,000) [1,2] of Asthma [3] Hospitalization for Children (aged less than 18 years) in Kalamazoo County, 1990-2002, Compared to the Healthy People 2010 Target (Objective 1-9a).



1 Population estimates are taken from the Michigan population estimates for 1990-2002.

2 Not age adjusted in accordance with analysis prescribed by Healthy People 2010 Objectives.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	0 to 17	
Year	Rate	Count
1990	28.4	155
1991	18.6	102
1992	20.6	114
1993	17.7	99
1994	16.8	95
1995	24.3	139
1996	20.8	119
1997	29.3	168
1998	19.7	113
1999	17.3	99
2000	15.7	90
2001	14.5	83
2002	10.8	62

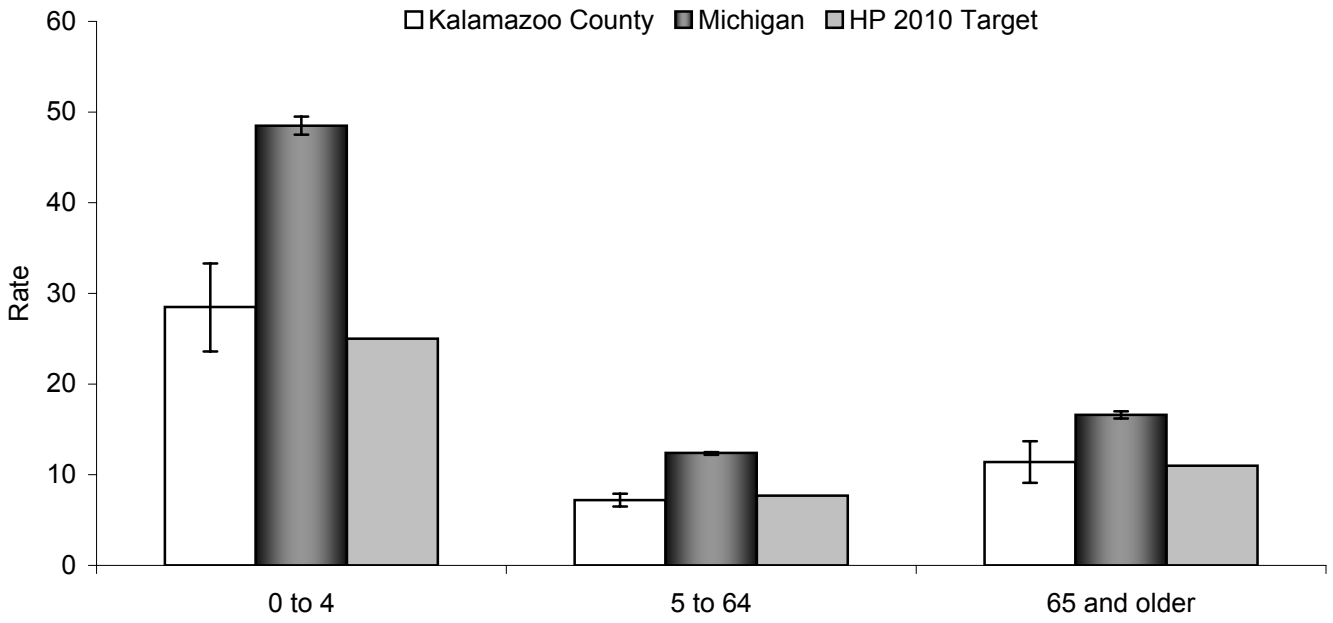
HP 2010 Target	**17.3**

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates among persons aged less than 18 years in Kalamazoo County (ρ = -0.59, $p < 0.05$).

See appendix page 45 for supporting data.

Figure 16. Rates (per 10,000) [1,2] of Hospitalization due to Asthma [3] by Age Group for Kalamazoo County and the State of Michigan, 2000-2002, Compared to the Healthy People 2010 Targets (Objective 24-2).



1 For age group 5-64 years and age group 65 and older, rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 2001.

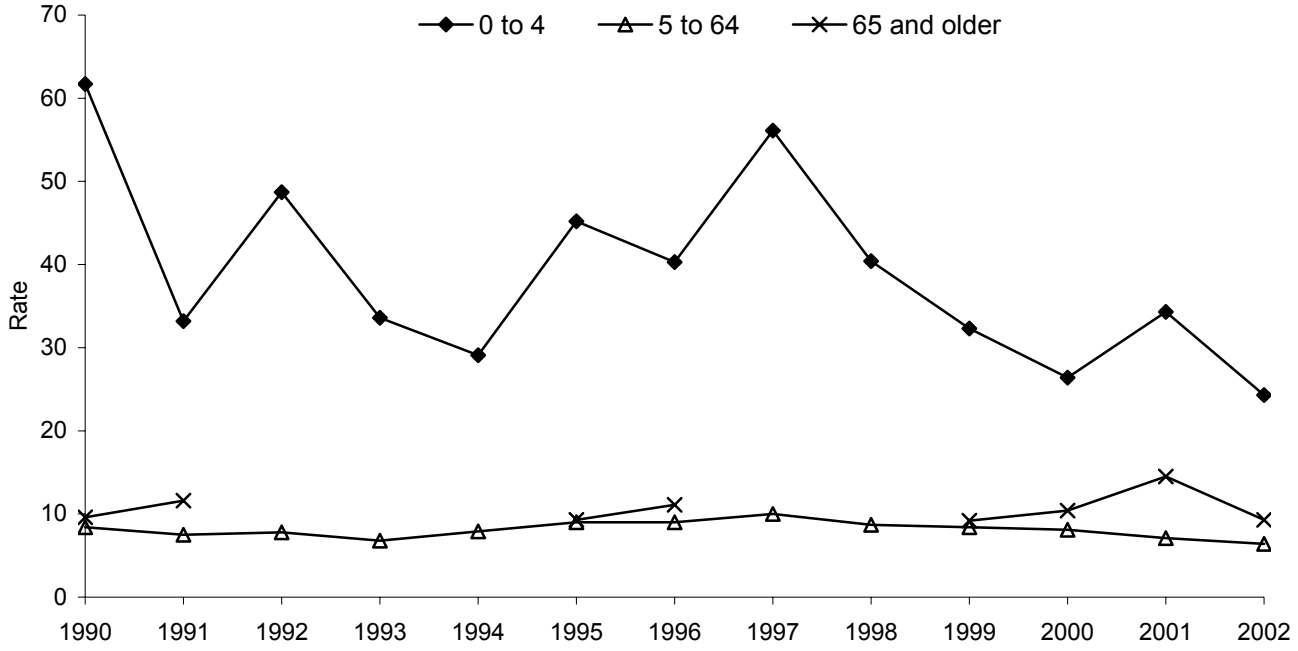
3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	0 to 4	5 to 64	65 and Older
Kalamazoo County Rate	28.5	7.2	11.4
95% CI	23.6 , 33.3	6.5 , 7.9	9.1 , 13.7
Count	132	404	95
Michigan Rate	48.5	12.4	16.6
95% CI	47.5 , 49.5	12.2 , 12.5	16.2 , 17.0
Count	9,637	30,198	6,110
HP 2010 Target	**25.0**	**7.7**	**11.0**

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ For all age groups, the rates of asthma hospitalization in Kalamazoo County are not significantly different than the respective *Healthy People 2010* Target Rates, 2000-2002.

Figure 17. Annual Rates (per 10,000) [1,2] of Asthma [3] Hospitalization by Age Group for Kalamazoo County, 1990-2002, Compared to the Healthy People 2010 Targets (Objective 24-2).



1 For age group 5-64 years and age group 65 and older, rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 1990-2002.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

	0 to 4		5 to 64		65 and Older	
Year	Rate	Count	Rate	Count	Rate	Count
1990	61.7	102	8.4	147	9.6	23
1991	33.2	55	7.5	133	11.6	28
1992	48.7	81	7.8	139	‡	15
1993	33.6	56	6.8	126	‡	16
1994	29.1	48	7.9	142	‡	20
1995	45.2	73	9.0	165	9.3	24
1996	40.3	64	9.0	165	11.1	29
1997	56.1	88	10.0	190	‡	15
1998	40.4	63	8.7	166	‡	19
1999	32.3	50	8.4	157	9.2	25
2000	26.4	41	8.1	149	10.4	29
2001	34.3	53	7.1	133	14.5	40
2002	24.3	38	6.4	122	9.3	26
HP 2010 Target	**25.0**		**7.7**		**11.0**	

‡ Insufficient data to compute a stable rate (number of events ≤20 or population <5000).

Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

✧ Between 1990 and 2002, there has not been a significant trend in asthma hospitalization rates for persons aged 0 to 4 years or 5 to 64 years in Kalamazoo County.

See appendix pages 46 through 48 for supporting data.

Section 4: Appendix

This appendix includes a compilation of supporting data tables presenting annual hospitalization rates for Kalamazoo County and the State of Michigan. It also includes a summary for Kalamazoo County of 3-year hospitalization rates by age, race, and sex strata.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year, All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	12.2	272	19.1	17,790
1991	9.8	216	18.1	16,995
1992	10.4	235	18.4	17,597
1993	8.6	198	19.8	18,975
1994	9.3	210	18.4	17,609
1995	11.5	262	19.5	18,945
1996	11.5	258	18.5	18,058
1997	12.7	293	17.7	17,320
1998	10.7	248	15.6	15,289
1999	10.1	232	15.6	15,385
2000	9.7	219	16.0	15,886
2001	10.0	226	15.5	15,363
2002	8.0	186	14.7	14,696

Spearman's ρ	-0.26	-0.79^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization in Michigan was 14.7 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for MALES All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	10.3	121	17.1	7,951
1991	9.3	99	15.7	7,345
1992	9.8	109	16.1	7,666
1993	6.9	80	16.6	7,929
1994	7.3	83	15.4	7,339
1995	9.5	109	17.1	8,275
1996	9.6	107	15.9	7,725
1997	10.7	124	15.4	7,546
1998	9.1	101	12.7	6,199
1999	8.4	93	12.7	6,229
2000	7.3	80	13.7	6,745
2001	7.2	77	12.8	6,271
2002	6.5	74	12.2	5,971

Spearman's ρ	-0.53	-0.82^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among males in Michigan was 12.2 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for males in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for FEMALES, All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	13.6	151	20.6	9,834
1991	10.1	117	20.0	9,648
1992	11.1	126	20.3	9,927
1993	10.1	118	22.6	11,043
1994	11.0	127	20.9	10,269
1995	13.2	153	21.6	10,668
1996	12.9	151	20.8	10,333
1997	14.2	169	19.6	9,774
1998	12.3	147	18.1	9,089
1999	11.6	139	18.1	9,155
2000	11.8	139	18.0	9,141
2001	12.5	149	17.8	9,092
2002	9.2	112	16.9	8,725

Spearman's ρ	-0.03	-0.76^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among females in Michigan was 16.9 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for females in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for WHITES [5], All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	9.2	176	15.1	11,791
1991	7.7	149	14.2	11,148
1992	8.6	168	14.1	11,165
1993	7.4	145	14.8	11,757
1994	7.2	139	13.2	10,488
1995	9.3	180	13.2	10,586
1996	9.0	174	12.6	10,140
1997	10.0	195	12.2	9,849
1998	8.0	157	10.5	8,522
1999	8.4	161	10.7	8,716
2000	7.0	135	10.8	8,781
2001	8.3	164	10.5	8,541
2002	6.1	119	9.9	8,133

Spearman's ρ	-0.32	-0.95^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

[5] For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among whites in Michigan was 9.9 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for whites in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for BLACKS [5], All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	41.7	96	43.0	5,800
1991	29.6	67	41.4	5,715
1992	28.9	62	44.4	6,209
1993	19.7	52	49.1	6,948
1994	28.7	68	48.5	6,858
1995	29.0	73	54.0	8,031
1996	35.0	81	51.3	7,603
1997	34.4	95	48.0	7,246
1998	33.2	84	45.3	6,607
1999	28.2	69	44.2	6,459
2000	31.0	80	45.2	6,888
2001	23.2	57	43.2	6,518
2002	26.1	61	42.0	6,279

Spearman's ρ	-0.30	-0.07

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

[5] For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among blacks in Michigan was 42.0 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, a significant overall trend in asthma hospitalization rates has not been observed for blacks in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for WHITE MALES [5], All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	8.5	83	13.4	5,142
1991	6.5	58	12.0	4,632
1992	7.6	71	12.1	4,715
1993	5.7	55	11.9	4,633
1994	5.7	55	10.4	4,033
1995	7.6	72	10.9	4,285
1996	7.9	73	10.2	4,012
1997	7.8	74	10.1	3,993
1998	6.8	62	8.1	3,198
1999	7.5	69	8.5	3,338
2000	5.1	45	8.9	3,499
2001	6.0	54	8.4	3,284
2002	5.0	47	8.0	3,133

Spearman's ρ	-0.47	-0.95^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

[5] For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among white males in Michigan was 8.0 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for white males in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for WHITE FEMALES [5], All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	9.6	93	16.5	6,647
1991	8.8	91	16.0	6,514
1992	9.7	97	15.7	6,446
1993	8.8	90	17.3	7,122
1994	8.3	84	15.6	6,455
1995	10.7	108	15.2	6,301
1996	9.8	101	14.8	6,128
1997	11.8	121	14.1	5,856
1998	9.3	95	12.7	5,324
1999	9.1	92	12.7	5,378
2000	8.8	90	12.5	5,282
2001	10.5	110	12.4	5,257
2002	6.9	72	11.6	5,000

Spearman's ρ	-0.06	-0.97^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

[5] For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among white females in Michigan was 11.6 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for white females in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for BLACK MALES [5], All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	27.9	38	39.2	2,721
1991	38.3	41	36.6	2,660
1992	29.7	35	39.0	2,864
1993	15.6	24	42.8	3,169
1994	18.2	26	43.1	3,176
1995	22.0	33	48.6	3,838
1996	21.1	33	45.8	3,569
1997	28.1	49	43.7	3,452
1998	20.7	35	38.3	2,927
1999	17.0	24	37.0	2,796
2000	19.8	34	39.4	3,147
2001	‡	19	36.6	2,856
2002	16.6	24	35.0	2,699

Spearman's ρ	ψ	-0.30

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

[5] For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

‡ Insufficient data to compute a stable rate (number of events ≤20 or population <5000).

ψ Insufficient data to compute Spearman Correlation Coefficient.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among black males in Michigan was 35.0 per 10,000 population.

SampleTrend Interpretation:
Between 1990 and 2002, a significant overall trend in asthma hospitalization rates has not been observed for black males in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for BLACK FEMALES [5], All Ages, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	53.6	58	45.3	3,079
1991	22.0	26	44.3	3,055
1992	27.6	27	47.8	3,345
1993	23.1	28	53.4	3,779
1994	37.2	42	51.9	3,682
1995	35.5	40	57.1	4,193
1996	45.7	48	54.7	4,034
1997	38.2	46	50.6	3,794
1998	42.9	49	50.0	3,680
1999	36.5	45	49.4	3,663
2000	38.7	46	49.0	3,741
2001	32.2	38	48.0	3,662
2002	32.5	37	47.0	3,580

Spearman's ρ	0.10	0.08

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

[5] For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among black females in Michigan was 47.0 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, a significant overall trend in asthma hospitalization rates has not been observed for black females in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for CHILDREN Aged 0 to 4 Years, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	61.7	102	66.1	4,712
1991	33.2	55	57.1	4,106
1992	48.7	81	64.4	4,638
1993	33.6	56	59.6	4,291
1994	29.1	48	53.2	3,783
1995	45.2	73	63.9	4,457
1996	40.3	64	59.6	4,092
1997	56.1	88	59.2	4,019
1998	40.4	63	40.5	2,734
1999	32.3	50	40.6	2,725
2000	26.4	41	48.8	3,257
2001	34.3	53	50.5	3,341
2002	24.3	38	45.8	3,039

Spearman's ρ	-0.50	-0.76^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are not age adjusted. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among children 0 to 4 years in Michigan was 45.8 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for children 0 to 4 years in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for CHILDREN Aged 5 to 14 Years, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	15.5	46	20.9	2,826
1991	13.3	40	19.4	2,666
1992	8.5	26	18.5	2,571
1993	11.0	34	21.1	2,972
1994	13.1	41	17.1	2,418
1995	18.3	58	21.9	3,152
1996	15.3	49	21.4	3,113
1997	20.4	66	22.1	3,244
1998	12.3	40	16.8	2,491
1999	14.4	47	16.8	2,497
2000	13.2	43	20.4	3,010
2001	7.1	23	16.0	2,363
2002	7.1	23	13.7	2,002

Spearman's ρ	-0.33	-0.48

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are not age adjusted. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among children 5 to 14 years in Michigan was 13.7 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, a significant overall trend in asthma hospitalization rates has not been observed for children 5 to 14 years in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for CHILDREN/ADULTS Aged 15 to 34 Years, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	5.9	48	9.1	2,709
1991	5.2	42	8.9	2,628
1992	5.3	42	9.8	2,839
1993	6.2	49	11.7	3,352
1994	4.6	36	10.9	3,081
1995	5.9	46	11.8	3,341
1996	6.3	49	11.5	3,220
1997	7.7	60	10.6	2,959
1998	6.7	52	10.0	2,755
1999	5.3	41	9.2	2,526
2000	4.1	32	9.2	2,502
2001	5.1	40	8.2	2,253
2002	4.3	34	7.7	2,104

Spearman's ρ	-0.30	-0.31

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are not age adjusted. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among children and adults 15 to 34 years in Michigan was 7.7 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, a significant overall trend in asthma hospitalization rates has not been observed for children and adults 15 to 34 years in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for ADULTS Aged 35 to 64 Years, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	7.3	53	14.8	4,694
1991	6.9	51	15.0	4,838
1992	9.4	71	14.5	4,795
1993	5.6	43	15.9	5,369
1994	8.2	65	16.0	5,509
1995	7.6	61	15.6	5,493
1996	8.2	67	15.0	5,401
1997	7.7	64	13.8	5,065
1998	8.8	74	14.2	5,275
1999	8.1	69	14.7	5,547
2000	8.6	74	13.6	5,264
2001	8.1	70	13.8	5,383
2002	7.4	65	13.5	5,317

Spearman's ρ	0.28	-0.70^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are not age adjusted. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among adults 35 to 64 years in Michigan was 13.5 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for adults 35 to 64 years in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for ADULTS Aged 65 Years and Older, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	9.7	23	25.7	2,849
1991	11.5	28	24.4	2,757
1992	‡	15	23.9	2,754
1993	‡	16	25.6	2,991
1994	‡	20	23.8	2,818
1995	9.2	24	20.9	2,502
1996	11.0	29	18.5	2,232
1997	‡	15	16.8	2,033
1998	‡	19	16.8	2,034
1999	9.3	25	17.2	2,090
2000	10.6	29	15.2	1,853
2001	14.5	40	16.5	2,023
2002	9.4	26	18.1	2,234

Spearman's ρ	ψ	-0.88^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are not age adjusted. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

‡ Insufficient data to compute a stable rate (number of events ≤20 or population <5000).

** Correlation is statistically significant; p-value < 0.01.

ψ Insufficient data to compute Spearman Correlation Coefficient.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among adults 65 years and older in Michigan was 18.1 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for adults 65 years and older in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for CHILDREN Aged Less Than 18 Years, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	26.7	155	31.7	8,063
1991	17.8	102	28.3	7,254
1992	19.3	114	29.9	7,735
1993	17.0	99	30.5	7,875
1994	16.3	95	26.2	6,757
1995	23.8	139	31.9	8,221
1996	20.6	119	30.2	7,769
1997	29.0	168	30.1	7,742
1998	19.6	113	21.8	5,594
1999	17.1	99	21.6	5,546
2000	15.6	90	26.3	6,693
2001	14.5	83	24.1	6,089
2002	10.8	62	21.3	5,359

Spearman's ρ	-0.53	$-0.68*$

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

* Correlation is statistically significant; p-value < 0.05.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among children less than 18 years in Michigan was 21.3 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for children less than 18 years in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3} Hospitalization [4] by Year for ADULTS Aged 18 Years and Older, for Kalamazoo County and the State of Michigan, 1990-2002.

Year	Kalamazoo County		Michigan	
	Rate	Count	Rate	Count
1990	7.2	117	14.7	9,727
1991	7.0	114	14.5	9,741
1992	7.4	121	14.5	9,862
1993	5.7	99	16.1	11,100
1994	6.9	115	15.7	10,852
1995	7.3	123	15.2	10,724
1996	8.2	139	14.5	10,289
1997	7.2	125	13.3	9,578
1998	7.7	135	13.4	9,695
1999	7.7	133	13.5	9,839
2000	7.7	129	12.5	9,193
2001	8.4	143	12.5	9,274
2002	7.1	124	12.5	9,337

Spearman's ρ	0.50	-0.80^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among adults 18 years and older in Michigan was 12.5 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for adults 18 years and older in Michigan.

Kalamazoo County

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] for Kalamazoo County, 2000-2002.

				95% Confidence Interval	
		Count	Rate	Lower Limit	Upper Limit
Total Population		631	9.2	8.5	10.0
Sex	Male	231	7.0	6.1	8.0
	Female	400	11.2	10.1	12.3
Race[5]	White	418	7.2	6.5	7.8
	Black	198	26.9	22.7	31.0
Sex and Race[5]	White Male	146	5.4	4.5	6.3
	White Female	272	8.7	7.7	9.8
	Black Male	77	16.6	12.3	20.9
	Black Female	121	34.7	28.1	41.2
Age (unadjusted)	0-4 Years	132	28.5	23.6	33.3
	5-14 Years	89	9.1	7.2	11.0
	15-34 Years	106	4.5	3.7	5.4
	35-64 Years	209	8.1	7.0	9.2
	65+ Years	95	11.5	9.2	13.8
Age	<18 Years	235	13.7	11.9	15.4
	18+ Years	396	7.7	7.0	8.5

For comparison, State of Michigan and Kalamazoo County 3-year rates are located within the Hospitalization section of this report.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] for Kalamazoo County, 2000-2002, Comparable to the Healthy People 2010 Targets.

				95% Confidence Interval	
		Count	Rate	Lower Limit	Upper Limit
Age	0-4 Years[6]	132	28.5	23.6	33.3
	5-64 Years	404	7.2	6.5	7.9
	65+ Years	95	11.4	9.1	13.7
	<18 Years[6]	235	13.7	11.9	15.4

For comparison, State of Michigan and Kalamazoo County 3-year rates are located within the Healthy People 2010 section of this report.

1 Unless otherwise noted, rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

2 Population estimates are taken from the Michigan population estimates for 2001.

3 Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

4 Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

5 For records that are missing data for race, race was assigned based on the 1990 census population for Michigan.

6 Not age adjusted in accordance with analysis prescribed by Healthy People 2010 Objectives.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for CHILDREN Aged Less Than 18 Years, for Kalamazoo County and the State of Michigan, 1990-2002, Compared to the Healthy People 2010 Target (Objective 1-9a).

Year	HP 2010 Objective	Kalamazoo County		Michigan	
		Rate	Count	Rate	Count
1990	17.3	28.4	155	32.8	8,063
1991	17.3	18.6	102	29.2	7,254
1992	17.3	20.6	114	30.9	7,735
1993	17.3	17.7	99	31.2	7,875
1994	17.3	16.8	95	26.6	6,757
1995	17.3	24.3	139	32.1	8,221
1996	17.3	20.8	119	30.1	7,769
1997	17.3	29.3	168	30.0	7,742
1998	17.3	19.7	113	21.7	5,594
1999	17.3	17.3	99	21.4	5,546
2000	17.3	15.7	90	26.0	6,693
2001	17.3	14.5	83	23.7	6,089
2002	17.3	10.8	62	20.8	5,359

Spearman's ρ	$-0.59*$	$-0.79**$

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are not age adjusted. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

* Correlation is statistically significant; p-value < 0.05.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among children less than 18 years in Michigan was 20.8 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for children less than 18 years in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for CHILDREN Aged 0 to 4 Years, for Kalamazoo County and the State of Michigan, 1990-2002, Compared to the Healthy People 2010 Target (Objective 24-2).

Year	HP 2010 Objective	Kalamazoo County		Michigan	
		Rate	Count	Rate	Count
1990	25.0	61.7	102	66.1	4,712
1991	25.0	33.2	55	57.1	4,106
1992	25.0	48.7	81	64.4	4,638
1993	25.0	33.6	56	59.6	4,291
1994	25.0	29.1	48	53.2	3,783
1995	25.0	45.2	73	63.9	4,457
1996	25.0	40.3	64	59.6	4,092
1997	25.0	56.1	88	59.2	4,019
1998	25.0	40.4	63	40.5	2,734
1999	25.0	32.3	50	40.6	2,725
2000	25.0	26.4	41	48.8	3,257
2001	25.0	34.3	53	50.5	3,341
2002	25.0	24.3	38	45.8	3,039

Spearman's ρ	-0.50	-0.76^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are not age adjusted. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

** Correlation is statistically significant; p-value < 0.01.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among children 0 to 4 years in Michigan was 45.8 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for children 0 to 4 years in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for CHILDREN/ADULTS Aged 5 to 64 Years, for Kalamazoo County and the State of Michigan, 1990-2002, Compared to the Healthy People 2010 Target (Objective 24-2).

Year	HP 2010 Objective	Kalamazoo County		Michigan	
		Rate	Count	Rate	Count
1990	7.7	8.4	147	14.0	10,229
1991	7.7	7.5	133	13.7	10,132
1992	7.7	7.8	139	13.6	10,205
1993	7.7	6.8	126	15.5	11,693
1994	7.7	7.9	142	14.5	11,008
1995	7.7	9.0	165	15.5	11,986
1996	7.7	9.0	165	15.0	11,734
1997	7.7	10.0	190	14.2	11,268
1998	7.7	8.7	166	13.2	10,521
1999	7.7	8.4	157	13.2	10,570
2000	7.7	8.1	149	13.3	10,776
2001	7.7	7.1	133	12.3	9,999
2002	7.7	6.4	122	11.5	9,423

Spearman's ρ	-0.07	$-0.63*$

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

* Correlation is statistically significant; p-value < 0.05.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among children and adults 5 to 64 years in Michigan was 11.5 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for children and adults 5 to 64 years in Michigan.

Counts and Rates (per 10,000) [1,2] of Asthma [3] Hospitalization [4] by Year for ADULTS Aged 65 Years and Older, for Kalamazoo County and the State of Michigan, 1990-2002, Compared to the Healthy People 2010 Target (Objective 24-2).

Year	HP 2010 Objective	Kalamazoo County		Michigan	
		Rate	Count	Rate	Count
1990	11.0	9.6	23	25.8	2,849
1991	11.0	11.6	28	24.3	2,757
1992	11.0	‡	15	23.9	2,754
1993	11.0	‡	16	25.5	2,991
1994	11.0	‡	20	23.9	2,818
1995	11.0	9.3	24	20.9	2,502
1996	11.0	11.1	29	18.6	2,232
1997	11.0	‡	15	16.8	2,033
1998	11.0	‡	19	16.8	2,034
1999	11.0	9.2	25	17.2	2,090
2000	11.0	10.4	29	15.2	1,853
2001	11.0	14.5	40	16.5	2,023
2002	11.0	9.3	26	18.1	2,234

Spearman's ρ	ψ	-0.87^{**}

[1] Population estimates are taken from the Michigan population estimates for 1990-2002.

[2] Rates are age adjusted to the 2000 US standard population by the direct standardization method. Hospitalization records with missing age are excluded.

[3] Asthma hospitalization is defined as a primary discharge diagnosis of asthma, ICD-9-CM=493.XX.

[4] Data Source: Michigan Inpatient Database, Bureau of Epidemiology, MDCH.

‡ Insufficient data to compute a stable rate (number of events ≤20 or population <5000).

** Correlation is statistically significant; p-value < 0.01.

ψ Insufficient data to compute Spearman Correlation Coefficient.

Sample Interpretation of Annual Rate:
In 2002, the rate of asthma hospitalization among adults 65 years and older in Michigan was 18.1 per 10,000 population.

Sample Trend Interpretation:
Between 1990 and 2002, there has been a significant overall decrease in asthma hospitalization rates for adults 65 years and older in Michigan.

Section 5: Data Sources

Name: Michigan Behavioral Risk Factor Surveillance System
Acronym: BRFSS
Basic Purpose and History: The BRFSS is a source of estimates of the prevalence of certain health behaviors, conditions, and practices associated with leading causes of death. Michigan has conducted the BRFSS survey since 1987. Asthma related questions were added to the survey in 2000.
Data Collection Process: Annual estimates are based on data collected from a random-digit dial telephone survey of a sample of Michigan households. It is a population-based representative sample of non-institutionalized Michigan residents. The data are weighted to represent estimates for the general adult population. BRFSS interviewers use a Computer Assisted Telephone Interviewing (CATI) system, which provides the interviewer with prompts. The interviewer types the respondent's responses directly onto the computer screen, providing quality control and minimizing interviewer error.
Population Included: A record is a completed telephone interview. The selected respondent must be a Michigan resident, 18 years of age or older who lives in a private residence and has a telephone. One randomly selected adult from a household is interviewed.
Asthma Data: There are two core questions dedicated to estimating asthma prevalence for the general population of adults. Michigan has opted to include the asthma module questions that include information about child prevalence and disease management/control. Finally, Michigan has also developed questions regarding work-related asthma. The following are the questions included on the Michigan BRFSS survey in 2001 regarding asthma:

Asthma Prevalence Questions for Adults:

- Have you ever been told by a doctor, nurse, or other health professional that you had asthma?
- Do you still have asthma?

Asthma Prevalence Questions for Children in the Household:

- Earlier you said there were <number> children, age 17 or younger, living in your household. How many of these children have ever been diagnosed with asthma?
- How many of these children/does this child still have asthma?

Additional Information: For more information about the BRFSS and national data for comparison, visit http://www.cdc.gov/brfss/index.htm. For a complete report of the Michigan BRFSS Survey, visit http://www.michigan.gov/mdch/0,1607,7-132--12702--,00.html.

Name: Michigan Inpatient Database
Acronym: MIDB
Basic Purpose and History: These data help support the State of Michigan health planning activities and are used by facilities themselves for internal evaluation. The Michigan Department of Community Health (MDCH) has purchased data since 1982.
Data Collection Process: Data are collected throughout a patient hospital stay by clinical and administrative staff and filed within a medical record. Hospital medical record personnel ascertain and keypunch information from these records. Some small hospitals complete data collection forms and send these directly to Michigan Health and Hospital Association (MHHA)

for processing. Depending on the facility, data are submitted on a voluntary basis monthly, quarterly, or annually to MHHA. Because data formats often differ by hospital, all coding is converted into standard formats at MHHA. The public use file provided to MDCH is stripped of all patient, provider, and hospital identifiers.
Population Included: Records include all hospital discharges from any of Michigan's reporting acute care hospitals or Michigan residents discharged from acute care hospitals in contiguous states. It includes virtually all hospitalizations in Michigan and for Michigan residents.
Asthma Data: The MIDB includes information on discharge diagnoses, which in the case of asthma includes the International Classification of Disease, Version 9, Clinical Modification (ICD-9-CM) codes 493.00-493.99. Procedure codes for treatments administered during the inpatient stay are also maintained in the dataset.
Additional Information: For the 2003 report on the *Michigan Hospital Profiles Project* published by MHHA, visit http://www.michiganhospitalprofiles.org/. For the latest data regarding preventable hospitalizations in Michigan, visit http://www.mdch.state.mi.us/pha/osr/chi/hosp/frame.html. The National Hospital Discharge Survey (NHDS) collects national data comparable to the MIDB. For more information about the NHDS and data for comparison, visit http://www.cdc.gov/nchs/about/major/hdasd/nhds.htm.

Name: Michigan Resident Death Files
Acronym: MRDF
Basic Purpose and History: The death certificate database is a high quality computerized data set containing demographic and cause of death information for all Michigan residents (out of state deaths included) and non-Michigan residents dying in Michigan. Death certificates are one of public health's vital records for monitoring the health of citizens. Death certificates have been collected in Michigan since 1897.
Data Collection Process: A funeral director, or another individual responsible for disposing of the body, completes the demographic and disposition components of the death certificate. When applicable, an attending physician or other hospital medical staff completes the portion of the death certificate describing the death (time, date, place, and immediate/underlying cause). A county medical examiner completes this section in all unexpected deaths including fatal injuries. The death certificate is then sent to the local registrar who verifies that the document has been properly filled out. If not, it is returned to the appropriate person for revision. Certificates for Michigan residents dying out-of-state are provided by those states (primarily Indiana, Ohio, and Wisconsin). Instructional materials to complete the death certificate are available at the state and local level for doctors, hospitals, medical examiners, and funeral directors. Michigan funeral director training also includes an annual seminar on death certificate completion.
Population Included: All instate occurrences regardless of the state of residence and all Michigan residents regardless of location of death are included.
Asthma Data: The MRDF includes information on causes of death, which in the case of asthma includes the International Classification of Disease (ICD), Version 9 codes 493 (1990-1998) and Version 10 codes J45 and J46 (1999-present).
Additional Information: For more data regarding Michigan mortality, visit http://www.mdch.state.mi.us/pha/osr/index.asp?Id=4. The National Center for Health Statistics maintains the National Vital Statistics System that provides a natural comparison to the MRDF. For more information, visit http://www.cdc.gov/nchs/about/major/dvs/mortdata.htm.

Section 6: Methods

Topic 1: Prevalence

Prevalence is the proportion of individuals in a population who have the disease at a point in time or during a given time period. It is often used to describe the health burden on a given population.

Prevalence is computed by dividing the number of existing cases at a particular point or period in time by the total population from which the cases came. It is often multiplied by 100 and expressed as a percent.

$$\text{Prevalence} = \frac{\text{number of existing cases of disease}}{\text{total population}}$$

In this report, prevalence estimates are generated in the analysis of data from the Behavioral Risk Factor Surveillance System.

Topic 2: Incidence Rate

The incidence rate expresses the rate at which events occur in a population at risk at any given point in time during a defined time period. Rates presented in this report are used to estimate annual incidence for aggregates of individuals, defined by geographic area and demographic characteristics, over a given time period.

The numerator of the incidence rate is the number of new events in the population during a given time period. The denominator is the average population estimated for that same time period multiplied by the number of years in the interval. The use of this denominator assumes that the population and its demographic composition are relatively stable.

The population at the midpoint of a given time interval is used to estimate the average population over the entire interval. This is then multiplied by the number of years in the interval so that an *annual* rate is generated. For example, to compute a rate of asthma hospitalizations for 1998 through 2000, the population in 1999 (midpoint) multiplied by 3 is used as the denominator. Rates for single years are calculated using the estimated population for that year.

$$\text{Annual Incidence Rate} = \frac{\text{number of new events during given time period}}{\text{average population X number of years in time period}}$$

Incidence rates are generally multiplied by a factor of 10 so that they can be better understood in terms of a population. For asthma hospitalizations, rates are multiplied by 10,000, whereas for asthma deaths, rates are multiplied by 1,000,000.

In this report, incidence rates are generated in the analysis of data from the Michigan Inpatient Database, Michigan Resident Death File.

Topic 3: Age Adjustment by Direct Standardization

Populations often differ in their distribution of age, which may in turn affect the overall rate of events in that population. For example, if one population has a larger number of young children than another, it could demonstrate a higher asthma hospitalization rate simply due to its age structure. Therefore, when comparing rates of events in populations of different age distributions, it is important to account for those differences. In this report, age structure differences are accounted for in overall rates using direct standardization methodology to compute age-adjusted rates. Rates that are not age adjusted are referred to as crude rates.

An age-adjusted rate is a weighted average of age group specific rates in the population under study. The age group specific rates are weighted by the number of people in each age group of a selected *standard* population. When two or more age-adjusted rates are computed using the same *standard* population, they may be compared. Age-adjusted rates are presented in this report so that comparisons can be made between geographic subgroups (ex. County vs. County) and demographic subgroups (ex. White vs. Black). The *standard* population used in the calculation of age-adjusted rates in this report is the 2000 United States Standard Population.

To compute an age-adjusted incidence rate, the first step is to compute the comprising age specific rates. These are then multiplied by the corresponding age specific weight, i.e. the proportion of people in a particular age strata in the *standard* population. The products of these calculations are then summed and divided by the sum of all the age specific weights.

$$\text{Age-Adjusted Incidence Rate} = \frac{\text{Sum of (age specific rate X age specific weight)}}{\text{Sum of age specific weights}}$$

In this report, age-adjusted rates are generated in the analysis of data from the Michigan Inpatient Database and the Michigan Resident Death File.

Topic 4: Confidence Interval

The purpose of a confidence interval (CI) is to estimate the statistical uncertainty around a particular measure. For example, the *estimated* prevalence of asthma among Michigan adults is 8.8%, with a 95% confidence interval of 7.8% to 9.8%; we are 95% confident that the *true* prevalence in the population is no less than 7.8% and no greater than 9.8%.

In this report, 95% confidence intervals are provided for average annual incidence rates.

The confidence interval formula for a crude incidence rate is based on the Poisson distribution. The upper and lower limits are often multiplied by an appropriate factor of 10: 10,000 for asthma hospitalization rates and 1,000,000 for asthma mortality rates.

Crude Incidence Rate CI = $IR_c \pm 1.96 \times \left(\frac{IR_c}{n}\right)^{1/2}$

Where IR_c = crude incidence rate
n = denominator of the rate

The confidence interval formula for an age-adjusted incidence rate is based on the Poisson distribution. The upper and lower limits are often multiplied by an appropriate factor of 10 – 10,000 for asthma hospitalization rates and 1,000,000 for asthma mortality rates.

Age-Adjusted Incidence Rate CI = $IR_a \pm 1.96 \times \left(\frac{\text{Sum } (W^2 \times I)}{(\text{Sum } W)^2}\right)^{1/2}$

Where IR_a = age-adjusted incidence rate
W = age specific weights from the *standard* population
I = variance of crude age specific rates

Confidence intervals can be used as a method to test whether a specific measure is statistically different between groups. For example, in comparing a county specific asthma hospitalization rate with that of the State of Michigan, they are considered statistically different if their confidence intervals do not overlap.

Topic 5: Data Suppression

Incidence rate estimates calculated with a small number of events or population sizes are statistically unstable. They exhibit wide confidence intervals indicative of great variability. In this report, data suppression rules are enforced so that the data presented are reliable. For demographic or geographic subgroups where there is less than or equal to 20 hospitalizations or less than 5000 population, asthma hospitalization rates are not presented. Mortality rates are suppressed when there is less than 5 deaths or less than 5000 population. In addition, to protect the identity of persons who have been hospitalized or died, counts less than 5 are not presented in this report.

Topic 6: Trend Analysis

To determine if there is an overall trend in annual asthma hospitalization and mortality rates over time, the Spearman Correlation Coefficient and its accompanying statistical Rank

Correlation Test were utilized. This test assesses whether there is a statistically significant monotonic relationship between 2 variables, in this case year and rate.

The Spearman Correlation Coefficient (rho, ρ) ranges from –1.0 to 1.0. If the coefficient equals –1.0, it indicates a perfect negative correlation, where each year has a lower hospitalization rate than the previous year. If the coefficient equals 1.0, it indicates a perfect positive correlation, where each year has a higher hospitalization rate than the previous year. As the correlation coefficient approaches 0.0, from either direction, the relationship between the 2 variables weakens. For example, a correlation coefficient of 0.90 indicates a stronger positive relationship between 2 variables than a coefficient of 0.50.

The p-value of the Rank Correlation test ranges from 0.0 to 1.0 and gives the probability of finding a significant overall monotonic trend in the asthma hospitalization rate data when, in reality, no trend exists. Again, the standard used to assess the significance of a statistical test is p-value = 0.05. A p value less than or equal to 0.05 indicates that there is at most a 5% chance of observing a trend, given that, in reality, rates are stable. In this case, the result is considered statistically significant. If the p value is greater than 0.05, chance cannot be excluded as a likely explanation for the observed trend, so the result is not considered statistically significant.
From this, it follows that:

- If there is a statistically significant **increase** in asthma hospitalization rates over time, the Spearman Correlation Coefficient will be **positive** and the p-value for the test will be **less** than 0.05.
- If there is a statistically significant **decrease** in asthma hospitalization rates over time, the Spearman Correlation Coefficient will be **negative** and the p-value for the test will be **less** than 0.05.

IMPORTANT: This is a crude analysis that simply identifies whether there is an **overall** increase or decrease in the asthma hospitalization or mortality rates. This statistical test does cannot determine the significance of more complex trend patterns. There is no way to know from these statistics if a specific event or series of events caused an observed change in rates.

References

Hennekens CH. And Buring JE. Ed. Mayrent SL. *Epidemiology in Medicine*. Boston, MA: Little, Brown, and Company, 1987.

Hollander M and Wolfe DA. *Nonparametric Statistical Methods, Second Edition*. New York: John Wiley & Sons, Inc., 1999

Klein RJ and Schoenborn CA. Healthy People 2010: *Age Adjustment Using the 2000 Projected U.S. Population*. Statistical Notes (20). Department of Health and Human Services. Centers for Disease Control and Prevention, National Center for Health Statistics. January 2001, (http://www.cdc.gov/nchs/data/statnt/statnt20.pdf).

Rothman KJ and Greenland S. *Modern Epidemiology, Second Edition.* Philadelphia: Lippincott-Raven Publishers, 1998.

Szklo M and Nieto FJ. *Epidemiology Beyond the Basics*. Gaithersburg, MD: Aspen Publishers, Inc., 2000.