City of Berkeley
Department of Health and Human Services
Public Health Division

Asthma Hospitalization Rates,

Berkeley, 1990-2006

Prepared by

Neil Maizlish, PhD, MPH, Epidemiologist

Asthma Hospitalization Rates, Berkeley, 1990-2006

SUMMARY

BACKGROUND

Why is this Topic Important?

1 in 6 children have asthma in some areas of the nation. Asthma has profound economic implications, as it is the leading cause of hospital stays in children and a leading cause of school absences. Asthma can also greatly reduce the quality of life for the child and their family.

Asthma hospitalization rates tell us about the impact of asthma in a community due to environmental and household triggers, access to medical care, and the quality of disease management for asthma. Hospitalization is the "tip of the iceberg": most people with asthma suffer the health impacts without needing hospitalization.

Purpose of this Report

This report describes who in Berkeley is impacted by asthma and if there have been changes over the last 17 years.

FINDINGS

Asthma decreasing overall in Berkeley:

- Over the entire 17-year period reviewed, asthma hospitalization rates (adjusted for age differences) declined an average of 2% per year. Between 1990 and 2006, the number of persons hospitalized for asthma each year ranged from 76 to 169, and the annual number of hospitalizations fluctuated from 93 to 200.
- Rates of asthma hospitalizations were highest for 0 to 4 year olds.
- From 1990 to 2002, hospitalization rates for 0 to 4 year olds went up an average of 6%, and from 2003 to 2006 these rates decreased an average of 16.5%, therefore the good news is that there are fewer and fewer asthma hospitalizations for children ages 0-4 years old in Berkeley.
- Asthma hospitalization rates declined for the age groups 5 to 14 years, 25 to 44 years, and 45 to 65 years as well.

Some groups in Berkeley are experiencing an increase in asthma:

- One Berkeley community is disproportionately suffering from asthma than any other group. African Americans had significantly higher rates than other race/ethnicity groups, and Asians had the lowest rates.
- While hospitalizations among Whites significantly decreased from 1990 to 2006 they significantly increased in African American children 0 to 4 years of age over that same time period.
- Asthma hospitalization rates for residents living in zip codes in South (94702, 94703) and West (94710) Berkeley – all lower income neighborhoods – were consistently higher

than rates for other wealthier Berkeley/Albany zip codes. Hospitalization rates in each of these three wealthier zip codes as well as 94704, 94707, and 94709, significantly decreased between 1990 and 2006. However, declining asthma hospitalization rates were not evident for children aged 0 to 4 years in zip codes 94702, 94703, and 94710. Children 0 to 4 years of age in zip codes 94705, 94706, and 94707 experienced significantly increasing rates between 1990 and 2006.

- Compared to the average in California, Berkeley has higher asthma hospitalization rates, but lower than the average for Alameda County.

RECOMMENDATIONS/FOLLOW-UP

This report shows that although there was an overall decline in the rate of asthma hospitalization in the past decade, certain populations in Berkeley suffer more asthma hospitalizations than others. Currently, the City of Berkeley does not have an asthma prevention, self-management and control program. Therefore, the Public Health Division recommends that, as resources become available, the following activities be conducted to address the asthma inequities found in this report:

A. Disseminate Results of the Study and Engage Stakeholders

1. Share results with community, affected populations and their advocates, health care providers and health plans to build partnerships and engage and garner community support.

2. Ensure community participation from affected populations in the planning, advising and staffing of a future asthma prevention, self-management and control program.

B. Strengthen Existing Public Health Division (PHD) Programs to Develop an Asthma Program

1. Improve our existing data collection systems to better locate communities that have significantly more cases of severe and uncontrolled asthma.

2. Use the study to guide discussion among PHD staff on how the findings factor into PHD priorities, program emphasis, and potential grant writing.

C. Strengthen Programs and Linkages with Other City Agencies and Community Partners

1. Discuss findings with City agencies that may have a role in facilitating public education and interventions.

2. Explore the partnership between the City of Berkeley School Linked Health Services Program and the Berkeley Unified School District in proposing a Comprehensive School-Based Asthma Program. Elements of the program could include: management of asthma medicines, parent and student asthma self-management education, staff education, indoor air quality improvement, and integrated pest management.

3. Assess the health impact of built environment/redevelopment plans on outdoor air quality in neighborhoods already impacted by vehicle and industrial air pollution.

4. Ensure that Berkeley residents at greatest risk of severe and uncontrolled asthma, are referred and followed-up by health care providers of established, local asthma programs.

D. Monitor Progress, Evaluate Existing Programs, and Identify Areas of Improvement/Need

1. Continue tracking asthma hospitalization rates to further inform program design and evaluate effectiveness.

2. Explore how Berkeley residents can utilize existing County-based programs and identify service gaps within these programs as well. This can include interventions that link individual home follow-up after a hospitalization.

3. Find school and community asthma education interventions that have been effective in facilitating families and schools to reduce indoor air triggers, teach patient and family self-management and asthma control. Especially relevant are the parent and pre-school education programs that work to prevent and control asthma in the 0-5 year old population.

E. Support the Development of Appropriate Policies

1. Support legislation, policies and institutional practices that positively impact resident's abilities to prevent, manage and control their asthma.

2. Identify incentives for homeowners, schools and local construction contractors to remediate indoor triggers of asthma.

3. Identify and support legislation, policies, and practices that improve the environment in neighborhoods where those most at risk live, learn, work, and play.

INTRODUCTION/BACKGROUND

Since the late 1980s, the Statewide Office of Health Planning & Development (OSHPD) has required all short stay civilian hospitals in California to report information on specific hospitalizations. In 2004, local health departments received authority (AB2876) to access individually identifiable patient records from OSHPD, thus expanding the possibilities to conduct epidemiologic surveillance of hospital-based conditions. This is especially important in distinguishing individual patients who may have multiple admissions. In 2007 the City of Berkeley requested and received an electronic dataset[1] from OSHPD that included all hospital admissions between 1990 and 2006 for patients with Berkeley residential zip codes (94702-94710).

The purpose of this report is to describe the demographics and statistical trends of asthma hospitalizations in Berkeley residents. In addition to documenting historical patterns, this information may useful for program planning.

METHODS

Data Sources

Asthma Hospitalizations

Computerized data files included a personal identifier of patients (encrypted Social Security Number, SSN), date of birth, gender, race/ethnicity, residential zip code, primary and secondary diagnoses (coded to the International Classification of Diseases, 9th revision, ICD-9) and procedures (also coded to ICD-9), expected source of payment, length of stay, and identifiers of the hospital. In the electronic data files, each row was a distinct hospitalization.

Population

Berkeley population denominators used in rates were estimated by linear interpolation (1991-1999) and linear extrapolation (2001-2006) from U.S. Census data from the 1990 and 2000 censuses.[2] Census data were aggregated into cells of age (6 categories: 0-4 years, 5-14, 15-24, 25-44, 45-64, 65+), sex, race/ethnicity (5 categories: Latino, White, African American, Asian, and Other), and 5-digit zip code (94702-94710).

Definitions

Asthma Hospitalization

An asthma hospitalization was defined as an admission in which the first three digits of the ICD9 code of primary diagnosis were 493. This definition is consistent with those of the Agency for Healthcare Research and Quality (AHRQ) and HEDIS, who use asthma hospitalization rates as a prevention and clinical quality indicator,[3, 4] and Alameda County and the City of Berkeley, who use asthma hospitalization rates as an indicator in health status reports.[5, 6]

Person

The encrypted SSN was basis for defining a unique person. However, approximately 30% of hospitalizations did not record a SSN. For this subgroup, a person identifier (PERSON_ID) was

created from the birth year (year of admission - age at admission), gender, race/ethnicity, and zip code. A unique PERSON_ID occurred in 72% of unique SSNs. PERSON_ID was less specific than encrypted SSN. Indeed, in the subgroup with known SSNs, 40% of PERSON_IDs were associated with 2 or more SSNs. This combination may have also generated false positives (unique individual assigned to two PERSON_IDs because of discrepancies in year of birth, sex, race/ethnicity, or zip code). Nonetheless, the use of the PERSON_ID improved the chances of distinguishing between individuals and hospitalizations in the subgroup with a missing SSN.

Age-Adjusted Rates

Rates for hospitalization were defined as the number of hospitalizations divided by the population counts. The rates were age-adjusted. Age-adjustment is a statistical technique that makes it possible to compare health outcomes of populations that have different age profiles. The technique is applied in three steps. First, the rate was calculated in specific age groupings (0-4 years, 5-14, 15-24, 25-44, 45-64, 65+.). These grouping were chosen because these were the same categories used in published data for Alameda County and California that serve as comparisons. Second, rather than taking a simple average these age-specific rates, each rate was multiplied (weighted) by the proportion of individuals in that age group that were estimated to be in the U.S. population in 2000.[203] Third, these weighted rates are summed. The sum reflects the weighted average, and is the age-adjusted rate.

Statistical Reliability of Rates

Rates of hospitalization based on large numbers of events are more reliable than those with only a few observations. Rates based on a small number of outcomes can fluctuate widely, making time trends difficult to discern or year-to-year changes seem spurious.

Analysts use several approaches to guide users in their interpretation of rates based on small numbers. Some agencies publish rates, but use symbols (e.g., asterisk) to warn readers that the rate does not meet a given reliability standard. Other agencies do not report results if the number of events do not meet a minimum number. There is no universally adopted minimum number, but many agencies' minimum number is in the range of 10 to 20.[5, 7-10] This range reflects a statistical zone in which measures of the variability in the rate (standard error) are between one-quarter to one-third of the value of the rate itself (i.e. a Relative Standard Error between 23% and 33%). For this report, we adopted the lower limit of 10, which strikes a balance between the amount of data that can be presented, particularly for Asians and Latino health outcomes, and the statistical reliability of rate measurements. The choice of 10 observations also helps prevent the potential identification of individuals and maintains confidentiality. Graphs in this report omit population groups with fewer than 10 observations in the numerator of a rate or proportion. This is the reason why some groups (e.g. Latinos) are included in some graphs and excluded from others.

To enhance the reliability of rates in some analyses of time trend, we aggregated data in 4- or 5-year intervals (1990-1993, 1994-1997, 1998-2001, and 2002-2006), so that, for most time periods, each population subgroup had at least 10 observations per time interval.

Statistical significance of differences in rates was assessed with chi square tests and a criterion level of $p < 0.05$. Annual trends in hospitalization rates were assessed with software that fit line segments to data (join points).[11] In subgroups with sparse annual numbers, observations were aggregated in 4-5 year periods (i.e., 1990-1993) and time trends were assessed with chi-square

for linear trend. Confidence intervals were calculated for rates using the exact Poisson distribution. Statistical calculations were made in STATA 10.

RESULTS

Hospitalizations and Persons

Between 1990 and 2006, the annual number of persons hospitalized for asthma ranged from 76 to 169, and the number of hospitalizations fluctuated from 93 to 200 (Table 1). Approximately 12%-16% of persons had multiple hospitalizations in each of the 4- to 5-year time periods. In each of the 4-5 year time periods, 12-16% of persons had multiple hospitalizations (Table 2). Age-adjusted rates fluctuated from a low of 92 per 100,000 to a high of 198 per 100,000, but, over the entire 17-year period, the rates statistically declined an average of 2% per year (p=0.03, log linear model with 0 join points) [Table 1, Figure 1]. Rates declined most steeply after 1998.

Age, Sex, Race/Ethnicity and Zip Code

Age-specific rates were highest for 0 to 4 year olds in each time period (Table 3, Figure 2).   For 0 to 4 year olds from 1990 to 2002, annual rates significantly increased an average of 6% (p=0.02), and from 2003 to 2006 annual rates nonsignificantly decreased an average of 16.5% (log linear model with 1 join point)[Figure 3]. Over all time periods, rates significantly declined for the age groups 5 to 14 years, 25 to 44 years, and 45 to 65 years.

Age-adjusted rates for males were not significantly different than those of females. Female rates significantly declined to their lowest levels in 2002-2006. Age-adjusted rates for African Americans were significantly higher than all other race/ethnicity groups, and Asians had the lowest rates in each time period (Table 3, Figure 5). Rates for Whites significantly declined in successive time periods (Figure 5). Hospitalization rates significantly increased in African American children 0 to 4 years of age over time (Figure 6).

Asthma hospitalization rates for South (94702, 94703) and West (94710) Berkeley zip codes were consistently higher than rates for other Berkeley/Albany zip codes (Figures 7-8). For all ages, hospitalization rates in each of these three zip codes as well as 94704, 94707, and 94709, significantly decreased in successive time periods between 1990 and 2006 (Figure 7). However, declining asthma hospitalization rates were not evident for children aged 0 to 4 years in zip codes 94702, 94703, and 94710. Children 0 to 4 years of age in zip codes 94705, 94706, and 94707 experienced significantly increasing rates between 1990 and 2006 (Figure 9).

Characteristics of Hospitalizations

In unadjusted dollars for 2002-2006, the annual sum of billed charges averaged $1,751,854 for the 123 hospitalizations (5-year average), or $14,243 per hospitalization (Table 5). The most costly single hospitalization generated $304,070 of billed charges. Medi-Cal was the expected source of payment in approximately 40% of hospitalizations from 2002 to 2006. The majority of hospital stays were 2 or fewer days. The proportion of stays of just 1 or 2 days increased over time. Hospital admissions peaked in the winter months of December through February and reached a low point in July. From 2002 to 2006, approximately 85% of hospitalizations were admitted to three hospitals: Children's Hospital (44.4%), Alta Bates Medical Center Main campus (25.5%), and Kaiser Oakland (16.1%). The distribution by hospital for residents of zip

codes 94702 and 94703, was similar to the overall pattern, but 67% of admissions in zip code 94710 occurred at Children's hospital.

DISCUSSION

Hospitalization for asthma is a marker for prevalence, access, and quality of ambulatory care.[3] Asthma is one of the leading causes of illness in children and a leading cause of school absenteeism, accounting for 12.8 million school days lost in the United States during 2003.[12] There are interventions that have reduced asthma hospitalizations by decreasing environmental allergens, such as second hand tobacco smoke and household dust (vacuums and covers for bedding), and by improved ambulatory care, including appropriate use of medications and patient self-management.[13-15]

Decades of national surveillance has established that asthma prevalence, hospitalization, and other indicators of morbidity occur more frequently in children, some race/ethnic groups (such as African Americans), and low income groups.[12,16] The findings of this report are consistent with these national trends, including the statistically significant decreasing trend in asthma hospitalization rates over the last two decades.[16] Although we did not have data on income or poverty status, Berkeley zip codes with the highest concentration of poverty also had the highest hospitalization rates.

Berkeley's overall asthma hospitalization rate declined from a peak in the late 1990s. The decline was most pronounced in adolescents and adults. Although the number of hospitalizations declined, children under 5 years of age account for an increasing share of asthma hospitalizations. There are also pronounced racial/ethnic and geographic disparities within Berkeley. African Americans have the highest rates of asthma hospitalization, which show no change over time. The South- and West-Berkeley zip codes with the highest overall rates (94702, 94703, and 94710), experienced significant declines over time, but zip codes 94706 and 94707 in the northwestern corner of Berkeley and zip code 94705 in the southeastern corner had increasing rates. From 2000 to 2004, Berkeley's asthma hospitalization rate was higher than the California average, but lower than the Alameda County average.

Multiple hospitalizations over a 4-5 year period occurred in approximately 12% of patients. Although reducing multiple hospitalizations is important, the overall rate was largely driven by singleton hospitalizations. This finding was made possible by the acquisition of a patient identifiable dataset, a first for the Berkeley Public Health Division. There are a limited number of health facilities where Berkeley residents are hospitalized. The present study provides data for designing and planning potential interventions. These might include case-based, active surveillance, educational outreach, coordination with other City and County agencies, community based organizations, and health care providers. They might also include place-based assessment and interventions addressing environmental contributors to asthma inequities.

There are several possible explanations for the decline in asthma hospitalization rates in Berkeley subgroups (Whites, selected zip codes). Asthma hospitalization rates may reflect the access to medical care, quality of medical care, prevalence of asthma triggers, and intervention programs. Data artifacts may also be among possible explanations.

Medi-Cal managed care got off to a start in the late 1990s and Berkeley Medi-Cal beneficiaries enrolled in one of the two county health plans. There is evidence that the introduction of managed care to Medi-Cal was associated with a significant decrease in hospital utilization for

ambulatory sensitive conditions, which includes asthma.[17] A putative mechanism might be increased access to primary care, with a concomitant decrease in emergency room and hospital utilization. The quality of care for asthma patients may also have been improved over time due to the increasing adoption of asthma treatment guidelines[14] by HMOs and medical groups, and to their participation in pay-for-performance incentive programs[18] that often included asthma as a clinical endpoint.

It is not known whether asthma environmental triggers may have changed or interventions have been implemented to reduce triggers. Triggers include antigens from pets and household pests, tobacco smoke, air pollution, and residence near a highway.[19, 15] Comprehensive strategies to reduce the household load of allergens appear to decrease hospital utilization.[13] We do not have data on whether residents – due to greater public recognition or recommendations of health care providers – have changed their household cleaning practices, the use of allergen-impermeable pillowcases and bed sheets, or tobacco use. Based on a household survey in 2001, smoking prevalence was higher in Berkeley adults living below the federal poverty level (21%) and in African Americans (19.5%) than in the general Berkeley population (13.9%).[6, p. 81] Albeit indirect evidence, this observation is consistent with the findings of higher asthma hospitalization rates in African Americans and zip codes with higher levels of neighborhood poverty.

In West Berkeley, a community debate has centered on the potential health impacts of emissions from a metal casting plant, forges, and other industrial facilities. Given the presence of multiple industrial firms, the proximity to an interstate highway and a railway corridor, attributing specific pollutants to specific sources and to health outcomes will be extremely difficult. We do not have specific data that links emissions from point or mobile sources of air contamination in West Berkeley to asthma hospitalization rates. In 2007, an air monitoring station was established in West Berkeley by the Bay Area Air Quality Management District (BAAQMD). In 2007, a community-based organization received grant funding by BAAQMD to deploy portable air sampling equipment in West Berkeley to collect roof-top air samples, some of which were reported to have daily average concentrations of heavy metals higher than the maximum recommended limits established by the U.S. Environmental Protection Agency or World Health Organization.[20] West Berkeley zip code 94710 has a high, but decreasing time trend of asthma hospitalization rates. Zip code 94706 has a much lower rate, which increased somewhat over time. Zip code 94705, which is farthest from the West Berkeley air pollution sources (but in the Ashby Ave. traffic corridor), also has low asthma hospitalization rates that appear to be increasing.

Limitations

The number of individuals in groups of age, sex, race/ethnicity, and zip code were estimated from changes in the 1990 and 2000 census. If population growth after 2000 were overstated by the estimates, the asthma hospitalization rates, having an inflated denominator, would be lower than their true value. This could explain in part the decline of asthma hospitalization rates. Annual estimates of the Berkeley population, broken down by age, sex, and race, are not calculated by the Department of Finance, which uses several population models at the county level and does a percentage wise reallocation to specific cities.[21] The Alameda County Health Department supplements data from Department of Finance with those of a commercial data provider (Claritas)[22] in order to create intercensus population projections in strata of age, sex, and race/ethnicity for individual census tracts and zip codes. The age-adjusted asthma hospitalization rate for Berkeley zip codes based on Claritas population projections for 2005 (Table 6) were 145 per 100,000 compared to 140 per 100,000 based on linear extrapolation, a

3% difference. This is not likely to explain differences between Berkeley's rate in comparison to Alameda County or California, and the declining trend in Berkeley asthma hospitalization rates since 1990. For all ages combined in 2005, the differences between Claritas and linear extrapolation estimates are generally ±5%. There are larger percentage wise differences within race/ethnicity and zip code strata in the smaller subgroup of 0 to 4 year olds. Differences in population estimates could play a larger role in explaining results at this subgroup level. However, for the main findings of this study there are no practical differences using either method to estimate the population at risk: high rates among 0 to 4 years olds, African Americans, and residents of zip codes 94702, 94703, and 94710 would remain high.

Asthma is sometimes difficult to diagnose and other conditions such as bronchitis or bronchiolitis may have been substituted and inflated hospitalization rates. However, national surveillance data has not raised this as a major explanation for changes in asthma prevalence over time.

RECOMMENDATIONS/FOLLOW-UP

This study has shown that certain populations in Berkeley suffer more asthma hospitalizations than others. Currently, the City of Berkeley does not have an asthma prevention, self-management and control program. Therefore, the Public Health Division recommends that, as resources become available, the following activities be conducted to address the asthma inequities found in this report:

A. Disseminate Results of the Study and Engage the Stakeholders

1. Share results with community, affected populations and their advocates, health care providers and health plans to build partnerships and engage and garner community support.

2. Spear head community capacity building efforts in South and West Berkeley to ensure community participation in the planning, advising and staffing of a future asthma prevention, self-management and control program.

B. Strengthen Existing Public Health Division (PHD) Programs to Develop an Asthma Program

1. Improve our existing data collection systems to better locate communities that have significantly more cases of severe and uncontrolled asthma. (e.g. Data from: Tobacco Prevention Program, School-linked Health Services, Child Health and Disability Prevention Program, Public Health Nursing.)

2. Use the study to guide discussion among PHD staff on how the findings factor into PHD priorities (early child development, healthy youth development, chronic illness prevention, and health disparities), program emphasis, and potential grant writing.

C. Strengthen Programs and Linkages with Other City Agencies and Community Partners

1. Discuss findings with City agencies such as Housing, Transportation and Public Works, Environmental Health, Toxics, and Planning (among others) who may have a role in facilitating public education and interventions.

For example, it may be useful to explore ways the Public Health Division and Housing agencies might to work together with owners and renters to improve indoor air quality for those with asthma (e.g., making HEPA filter vacuums available, allergen trapping pillow sheet and bed sheet exchanges, vermin eradication and training their staff to provide interagency referrals).

2. Explore the partnership between the City of Berkeley School Linked Health Services Program and the Berkeley Unified School District in proposing a Comprehensive School-Based Asthma Program. Elements of the program could include: improving linkage between primary care providers and school staff, asthma diagnosis services on site, management of medicines, parent and student asthma self-management education, staff education, indoor air quality improvement, and integrated pest management.

3. Assess the health impact of built environment/redevelopment plans on outdoor air quality in neighborhoods already impacted by vehicle and industrial air pollution.

4. Ensure that Berkeley residents at greatest risk of severe and uncontrolled asthma, are referred and followed-up by health care providers of established, local asthma programs, including Oakland Kicks Asthma, Asthma Starts, Healthy Homes, Alameda Alliance, Blue Cross, Kaiser and other health plans, Children's Hospital – Oakland, the American Lung Association, the Alameda County Health Department, the Breath-mobile, the Alameda County Asthma Coalition and others.

D. Monitor Progress, Evaluate Existing Programs, and Identify Areas of Improvement/Need

1. Continue tracking asthma hospitalization rates and explore additional data sources for tracking prevalence rates to further inform program design and evaluate effectiveness.

2. Explore how Berkeley residents can utilize existing County-based programs (Asthma Start, Healthy homes) and identify service gaps within these programs as well. This can include interventions that link individual home follow-up after a hospitalization.

3. Find school and community asthma education interventions that have been effective in facilitating families and schools to reduce indoor air triggers, teach patient and family self-management and asthma control. Especially relevant are the parent and pre-school education programs that work to prevent and control asthma in the 0-5 year old population.

E. Support the Development of Appropriate Policies

1. Support legislation, policies and institutional practices that positively impact resident's abilities to prevent, manage and control their asthma.

2. Identify incentives for homeowners, schools and local construction contractors to remediate indoor triggers of asthma.

3. Identify and support legislation, policies, and practices that improve the environment in neighborhoods where those most at risk live, learn, work, and play.

ACKNOWLEDGEMENTS

REFERENCES

1. Statewide Office of Health Planning & Development Patient Discharge Data File Documentation, January-December 2006 (www.oshpd.ca.gov/HID/Products/ PatDischargeData/PublicDataSet/Doc/PD06docwapp.pdf). Sacramento: Statewide Office of Health Planning & Development; 2007.

2. U.S. Bureau of Census. Summary Files 1-4. Detailed Tables (http://factfinder.census.gov/ servlet/DatasetMainPageServlet?_program=DEC&_submenuId=datasets_1&_lang=en). Washington, DC: U.S. Bureau of Census; 2000.

3. Agency for Healthcare Research & Quality. Guide to Prevention Quality Indicators: Hospital Admission for Ambulatory Care Sensitive Conditions. Version 3.1. Gaithersburg, MD: Agency for Healthcare Research & Quality; 2007.

4. National Committee for Quality Assurance. Health Employers Data and Information Set (HEDIS). Volume 2. Technical Specifications. Washington, DC: National Committee for Quality Assurance; 2007.

5. Alameda County Public Health Department. Alameda County Health Status Report 2006. Oakland: Alameda County Public Health Department; 2006.

6. Breckwich-Vazquez V, Maizlish N, Ducos J, Rudolph L. City of Berkeley, Health Status Report, 2007. Berkeley: Public Health Division, Department of Health & Human Services, City of Berkeley; 2007.

7. California Department of Health Services, California Conference of Local Health Officers. County Health Status Profiles, 2006. Sacramento, CA: California Department of Health Services; 2006.

8. Greater Bay Area Cancer Registry. Five-Year Average Annual Age-Adjusted Incidence Rate (per 100,000) for All Cancers and Selected Sites for Berkeley, Alameda County, and California by Sex and Race/Ethnicity, 1998-2002 (Census 2000 denominators multiplied by 5). Oakland: Greater Bay Area Cancer Registry (www.nccc.org/ResearchandTraining/ research_gbareg.html); 2007.

9. Hoyert DL, Heron MP, Murphy SL, Kung H. Deaths: Final Data for 2003. National Vital Statistics Reports. Vol. 54 No 13. Hyattsville, MD: National Center for Health Statistics; 2006.

10. New York Department of Health. Rates Based on Small Numbers: Why are rates based on fewer than 20 cases marked as being unreliable? (www.health.state.ny.us/diseases/ chronic/ratesmall.htm). Albany, NY: New York Department of Health; 1999.

11. Statistical Research and Applications Branch. Joinpoint Regression Program, Version 3.0. April 2005 (srab.cancer.gov/joinpoint). Silver Spring, MD: National Cancer Institute; 2005.

12. Akinbami LJ. The State of Childhood Asthma, United States, 1980–2005. Advance Data from Vital and Health Statistics. No. 381. Hyattsville, MD: National Center for Health Statistics; 2006.

13. Krieger JW, Takaro TK, Song L, Weaver M. The Seattle-King County Healthy Homes Project: a randomized, controlled trial of a community health worker intervention to decrease exposure to indoor asthma triggers. Am J Public Health 2005;95:652-659.

14. National Heart, Lung, and Blood Institute. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. Full Report 2007. Washington, DC: U.S. Department of Health and Human Services; 2007.

15. Platts-Mills T, Leung DY, Schatz M. The role of allergens in asthma. Am Fam Physician 2007;76:675-680.

16. Centers for Disease Control and Prevention. National Surveillance for Asthma — United States, 1980–2004. MMWR 2007;56(No. SS-8).

17. Bindman AB, Chattopadhyay A, Osmond DH, Huen W, Bacchetti P. The impact of Medicaid managed care on hospitalizations for ambulatory care sensitive conditions. Health Services Research 2005;40:19-38.

18. Integrated Healthcare Association. Advancing Quality Through Collaboration: The California Pay for Performance Program. A Report on the First Five Years and a Strategic Plan for the Next Five Years (www.iha.org/wp020606.pdf). Walnut Creek, CA: Integrated Healthcare Association; 2006.

19. Gauderman WJ, Vora H, McConnell R, Berhane K, Gilliland F, Thomas D, et al. Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. lancet 2007;369:571-577.

20. Dulan D, Ferro V, Lawler, Ling J, Macias B, Johnson M, et al. West Berkeley Air Monitoring Project - Fall '07. University of California, Berkeley: ESPM 163AC-Environmental Justice (Student Class) 2007.

21. Department of Finance. E-4 Population Estimates for Cities, Counties and the State, 2001-2007, with 2000 Benchmark (www.dof.ca.gov/HTML/DEMOGRAP/ReportsPapers/Estimates/E4/E4-01-06/documents/Hist_E-4.xls) Sacramento, CA: State of California; 2007.

22. Claritas. Claritas Update Demographics Methodology (www.claritas.com/collateral/methodology/2007_demographic_methodology.pdf): Claritas, Inc.; 2007.

Table 1. Age-Adjusted Rate of Asthma Hospitalizations, 1990-2006

Item	Persons*			Hospitalizations		
	N	Rate[†]	95%CI	N	Rate[†]	95%CI
1990	131	132	109 – 156	147	147	122 – 172
1991	146	149	124 – 174	171	173	146 – 200
1992	133	143	118 – 168	154	167	140 – 194
1993	148	153	127 – 178	179	188	160 – 217
1994	118	125	101 – 148	146	153	127 – 179
1995	119	120	97 – 142	132	134	110 – 158
1996	97	99	79 – 119	132	131	108 – 154
1997	158	159	133 – 184	200	198	170 – 227
1998	169	174	147 – 201	189	194	165 – 222
1999	147	151	126 – 177	165	169	142 – 196
2000	102	109	87 – 131	140	147	122 – 172
2001	107	112	90 – 134	122	127	103 – 150
2002	118	127	103 – 150	139	149	124 – 175
2003	111	118	95 – 140	121	128	105 – 152
2004	76	75	58 – 93	93	92	72 – 111
2005	122	124	101 –146	140	140	116 – 164
2006	92	92	72 – 111	122	114	93 – 136
1990-1993	558	144	132 – 157	651	169	155 – 182
1994-1997	492	126	114 – 137	610	154	141 – 167
1998-2001	525	137	124 – 149	616	159	146 – 172
2002-2006	519	107	97 – 117	615	125	115 – 135

* Persons with ≥1 hospitalizations
[†] Rate per 100,000 adjusted to age distribution of 2000 U.S. Standard Population

Table 2. Distribution of Persons by the Number of Hospitalizations, Berkeley, 1990-2006

Number of Hospitalizations	Persons							
	1990–1993		1994–1997		1998–2001		2002–2006	
	N	%	N	%	N	%	N	%
1	483	86.6	412	83.7	458	87.2	455	87.7
2	61	10.9	63	12.8	52	9.9	48	9.3
3+	14	2.5	17	3.5	15	2.9	16	3.0

* Those with <1 day of stay excluded

Table 3. Asthma Hospitalization Rates by Demographic Characteristics, Berkeley, 1990-2006

Item	1990–1993				1994–1997				1998–2001				2002–2006			
	N	%	Rate*	95%CI	N	%	Rate	95%CI	N	%	Rate	95%CI	N	%	Rate	95%CI
Age (Years)																
0–4	116	21	493	404–583	103	21	453	366–541	154	29	701	591–812	160	31	608	514–702
5–14	108	19	273†	221–324	112	23	271	221–322	113	22	263	215–312	93	18	166	132–200
15–24	30	5	28	18–38	41	8	38	26–50	33	6	31	20–41	27	5	20	13–28
25–44	105	19	60†	48–71	76	15	45	35–55	73	14	45	35–56	53	10	28	20–35
45–64	106	19	122†	99–146	90	18	89	71–108	83	16	72	57–88	93	18	57	45–69
65+	93	17	170	135–204	70	14	128	98–158	69	13	126	96–156	93	18	136	108–163
Sex																
Female	369	57	174	155–193	330	54	150	133–167	324	53	149	132–166	314	51	112	99–126
Male	282	43	159	140–178	280	46	155	137–174	292	47	166	147–185	301	49	134	118–149
Ethnicity																
African Am.	368	57	493	443–544	316	52	479	426–532	311	51	579	515–644	330	54	581	516–645
Asian/P.I.	27	4	55	33–78	22	4	48	27–69	29	5	64	39–89	25	4	38	22–53
Latino	29	5	107	65–150	42	7	112	75–148	44	7	118	79–158	54	9	110	76–144
Other	14	2	98	39–157	36	6	144	93–195	46	7	177	115–239	64	10	165	118–213
White	205	32	92†	79–105	191	31	80	68–92	185	30	88	74–101	142	23	56	46–66
Zip Code																
94702	208	32	366†	315–417	164	27	298	252–344	185	30	341	291–390	164	27	233	197–269
94703	155	24	244†	205–283	179	30	282	240–324	165	27	253	214–292	178	29	206	175–238
94704	47	7	205†	140–269	32	5	126	73–180	16	3	54	21–87	32	5	87	52–122
94705	38	6	84	57–112	31	5	75	48–103	54	9	130	93–166	38	6	92	61–122
94706	54	8	81	59–103	66	11	106	80–132	69	11	113	86–140	72	12	117	89–145
94707	28	4	67†	41–92	13	2	31	14–49	30	5	75	48–103	21	3	38	21–55
94708	18	3	53	27–78	22	4	57	31–83	27	4	71	43–100	27	4	61	37–85
94709	22	3	112†	56–168	15	2	61	27–95	9	1	34	8–59	15	2	51	23–79
94710	77	12	280†	217–343	82	14	277	216–338	54	9	177	128–226	58	10	140	102–177

* Rate per 100,000 adjusted to age distribution of 2000 U.S. Standard Population
† Significantly decreasing time trend

Table 4. Asthma Hospitalization Rates by Demographic Characteristics, 0-4 Year Olds, Berkeley, 1990-2006

Item		1990–1993				1994–1997				1998–2001				2002–2006		
	N	%	Rate	95%CI	N	%	Rate	95%CI	N	%	Rate	95%CI	N	%	Rate	95%CI
Sex																
Female	62	40	527	396–658	35	28	311	208–414	67	35	622	473–771	62	34	487	365–608
Male	92	60	783	623–943	90	72	786	623–948	122	65	1091	897–1284	121	66	891	732–1050
Ethnicity																
African Am.	71	54	1492	1145–1839	61	49	1566	1173–1959	89	47	2905	2301–3508	63	34	2389	1799–2979
Asian/P.I.	9	7	309	107–510	7	6	261	68–455	9	5	369	128–610	<5			
Latino	9	7	320	111–529	16	13	513	262–765	12	6	353	153–553	31	17	662	429–895
Other	5	4	282	35–529	19	15	885	487–1282	24	13	957	574–1340	40	22	1096	756–1435
White	37	28	329	223–435	22	18	202	118–287	54	29	512	376–649	46	25	364	259–469
Zip Code																
94702	32	24	904	591–1218	33	27	958	631–1284	55	29	1632	1201–2063	36	20	891	600–1182
94703	38	29	818	558–1078	32	26	725	474–976	57	30	1356	1004–1708	44	24	898	633–1163
94704	9	7	682	237–1128	8	7	667	205–1130	<5				<5			
94705	6	5	252†	50–453	9	7	408	141–674	13	7	641	293–990	16	9	701	357–1044
94706	16	12	340†	173–506	9	7	226	78–373	12	6	366	159–574	23	13	739	437–1041
94707	<5				<5				17	9	697	366–1029	12	7	366	159–573
94708	<5				<5				12	6	626	272–981	12	7	453	197–709
94709	6	5	558	112–1005	5	4	477	59–895	<5				<5			
94710	20	15	931	523–1339	20	16	834	469–1200	17	9	644	338–951	30	17	821	527–1115

* Rate per 100,000 adjusted to age distribution of 2000 U.S. Standard Population
† Significantly decreasing time trend

Table 5. Characteristics of Hospitalizations, Berkeley, All Ages, 1990-2006

Item	1990–1993		1994–1997		1998–2001		2002–2006	
	N	%	N	%	N	%	N	%
Total	651	100	610	100	616	100	615	100
Payer								
Medicare	134	20.6	97	15.9	81	13.2	120	19.5
Medi-Cal	247	37.9	260	42.6	225	36.5	244	39.7
Private Ins., incl. Pre-paid	231	35.5	192	31.5	247	40.1	203	33.0
Self-Pay	15	2.3	15	2.5	14	2.3	17	2.8
Other Government	17	2.6	14	2.3	34	5.5	18	2.9
Other	7	1.1	32	5.3	15	2.4	13	2.1
Month of Year								
Jan.	64	9.8	64	10.5	71	11.5	65	10.6
Feb.	59	9.1	66	10.8	63	10.2	77	12.5
Mar.	58	8.9	56	9.2	45	7.3	43	7.0
Apr.	43	6.6	35	5.7	50	8.1	41	6.7
May	28	4.3	42	6.9	41	6.7	49	8.0
Jun.	40	6.1	44	7.2	47	7.6	34	5.5
Jul.	30	4.6	25	4.1	23	3.7	23	3.7
Aug.	46	7.1	35	5.7	35	5.7	45	7.3
Sep.	74	11.4	55	9.0	58	9.4	62	10.1
Oct.	58	8.9	48	7.9	55	8.9	55	8.9
Nov.	66	10.1	64	10.5	66	10.7	65	10.6
Dec.	85	13.1	76	12.5	62	10.1	56	9.1
Length of stay (days)								
1 or less	142	21.8	181	29.7	226	36.7	223	36.3
2	149	22.9	142	23.3	151	24.5	172	28.0
3	109	16.7	105	17.2	90	14.6	87	14.2
4	71	10.9	58	9.5	53	8.6	42	6.8
5	45	6.9	40	6.6	35	5.7	28	4.6
6-9	76	11.7	62	10.2	43	7.0	44	7.2
10+	59	9.1	22	3.6	18	2.9	19	3.1
Billed Charges*, $								
Sum	5,768,384		5,897,251		6,050,933		8,759,268	
Annual Sum	1,442,096		1,474,313		1,512,733		1,751,854	
Mean per admission	8,861		9,668		9,823		14,243	
Maximum per admission	290,991		259,929		191,385		304,070	

* Not adjusted for inflation

Table 5. Characteristics of Hospitalizations, Berkeley, 1990-2006 (continued)

Item	1990–1993 N	%	1994–1997 N	%	1998–2001 N	%	2002–2006 N	%
Total	651	100	610	100	616	100	615	100
Hospital								
Alta Bates Medical Center	220	33.8	208	34.1	169	27.4	157	25.5
Children's Hospital	234	35.9	267	43.8	298	48.4	273	44.4
Kaiser-Oakland	109	16.7	58	9.5	73	11.9	99	16.1
Alameda Co. Medical Center	22	3.4	17	2.8	20	3.3	15	2.4
Summit Medical Center	13	2.0	20	3.3	16	2.6	35	5.7
All Others	53	8.1	40	6.6	40	6.5	36	5.9
Residents of Zip Codes:								
94702								
Alta Bates Medical Center	73	35.1	50	30.5	54	29.2	41	25.0
Children's Hospital	61	29.3	76	46.3	98	53.0	66	40.2
Kaiser-Oakland	38	18.3	16	9.8	10	5.4	33	20.1
Alameda Co. Medical Center	14	6.7	7	4.3	11	6.0	11	6.7
Summit Medical Center	5	2.4	<5		7	3.8	6	3.7
All Others	17	8.2	12	7.3	5	2.7	7	4.3
94703								
Alta Bates Medical Center	44	28.4	66	36.9	33	20.0	56	31.5
Children's Hospital	63	40.7	89	49.7	94	57.0	79	44.4
Kaiser-Oakland	32	20.7	9	5.0	18	10.9	24	13.5
Alameda Co. Medical Center	<5		5	2.8	5	3.0	<5	
Summit Medical Center	5	3.2	6	3.4	<5		10	5.6
All Others	9	5.8	<5		12	7.3	8	4.5
94710								
Alta Bates Medical Center	17	22.1	28	34.2	10	18.5	7	12.1
Children's Hospital	50	64.9	42	51.2	30	55.6	39	67.2
Kaiser-Oakland	5	6.5	<5		7	13.0	9	15.5
Alameda Co. Medical Center	<5		<5		<5		<5	
Summit Medical Center	<5		<5		<5		<5	
All Others	<5		6	7.3	<5		<5	

Table 6. Population Estimates of residents in Berkeley Zip Codes (94702-94710) for 2005
From Linear Extrapolation of 1990 to 2000 Changes in U.S. Census and Claritas Commercial Database

Item	Linear	Claritas*	Difference	Percent Difference[†]
A. Total, All Ages	128,332	126,163	2,169	2
Age				
0-4	5,199	5,414	-215	-4
5-14	11,321	10,838	483	4
15-24	26,598	22,888	3,710	14
25-44	38,011	39,702	-1,691	-4
45-64	33,507	33,392	115	0
65+	13,696	13,929	-233	-2
Race/Ethnicity				
White	73,265	70,704	2,561	3
Latino	12,730	12,397	333	3
African Am.	11,620	12,250	-630	-5
Asian/PI	23,125	23,527	-402	-2
Other	7,592	7,285	307	4
Zip Code				
94702	15,909	15,897	12	0
94703	20,478	20,110	368	2
94704	20,080	20,508	-428	-2
94705	12,670	12,668	2	0
94706	15,274	16,054	-780	-5
94707	13,168	11,454	1,714	13
94708	11,736	10,879	857	7
94709	10,244	10,312	-68	-1
94710	8,773	8,281	492	6
B. 0-4 Years				
Race/Ethnicity				
White	2501	2485	16	1
Latino	953	925	28	3
African Am.	469	623	-154	-33
Asian/PI	529	726	-197	-37
Other	747	655	92	12
Zip Code				
94702	797	827	-30	-4
94703	960	1060	-100	-10
94704	227	290	-63	-28
94705	445	491	-46	-10
94706	576	805	-229	-40
94707	667	584	83	12
94708	540	460	80	15
94709	246	243	3	1
94710	741	654	87	12

* Claritas, Inc. uses data from municipal government agencies, U.S. Postal Service address corrections, credit rating bureaus, and other sources to adjust base counts from the 2000 U.S. Census
+ Percent Difference = 100 × (Population$_{Linear}$ − Population$_{Claritas}$)/ Population$_{Linear}$
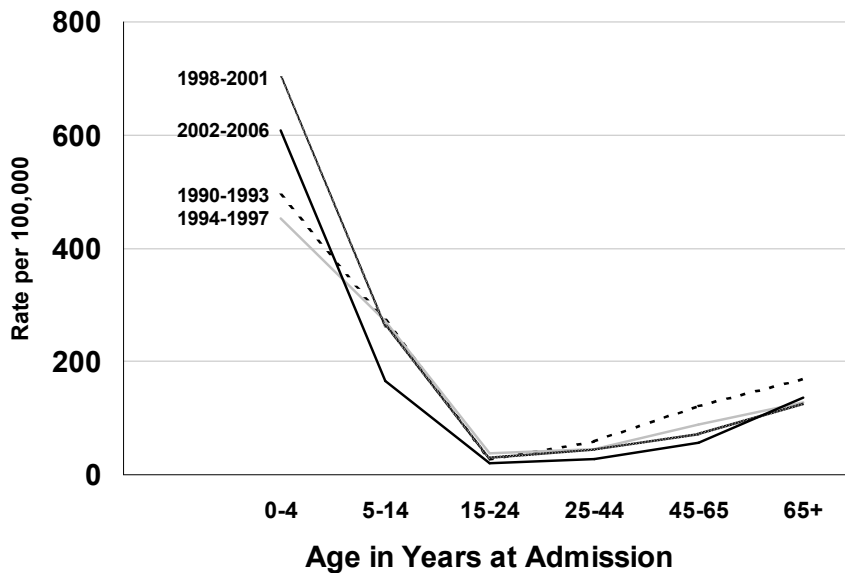
Figure 1 . Annual Asthma Hospitalization Rate and 95% Confidence Interval, Berkeley, 1990-2006
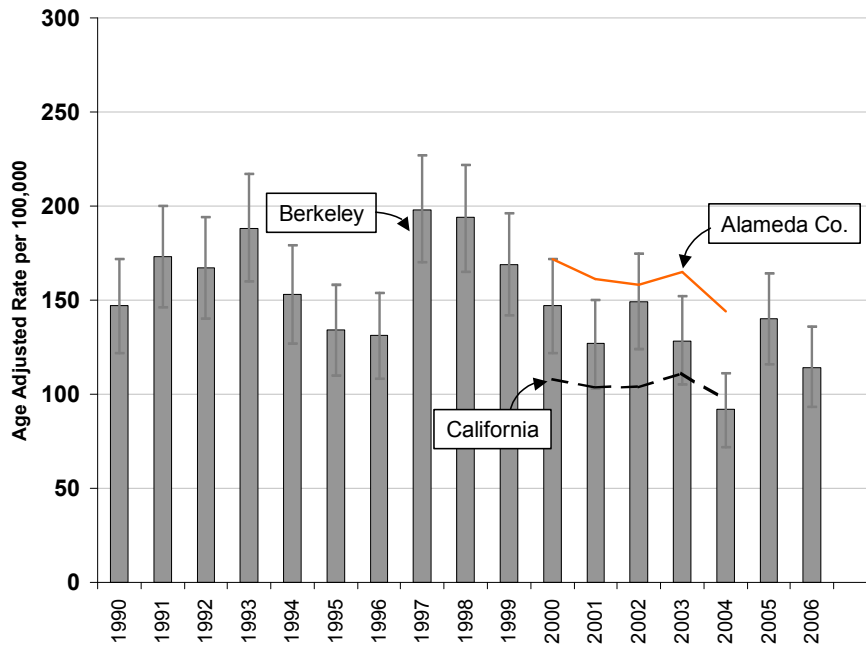
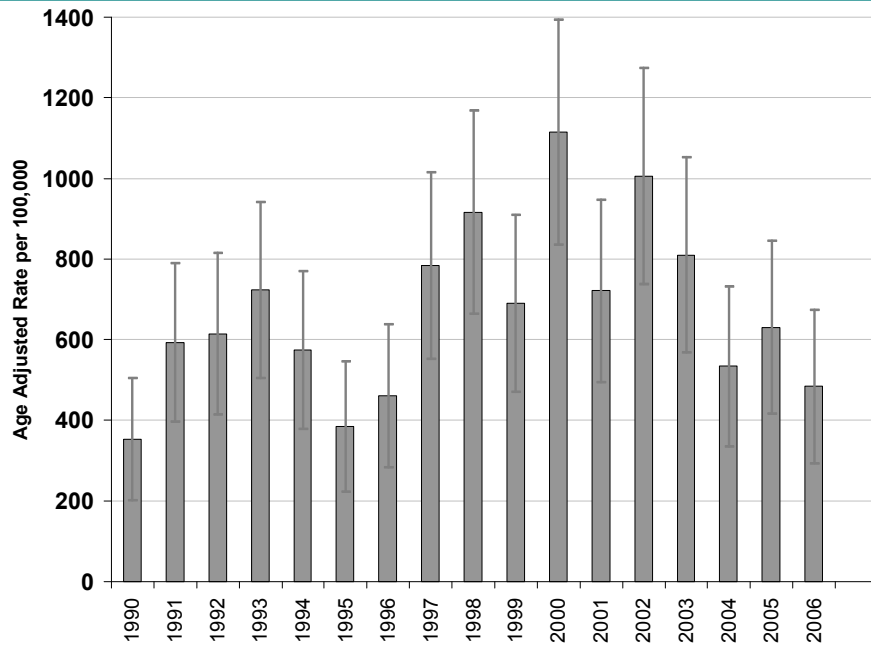Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000

Figure 2. Age-Specific Asthma Hospitalization Rates, Berkeley, 1990-2006

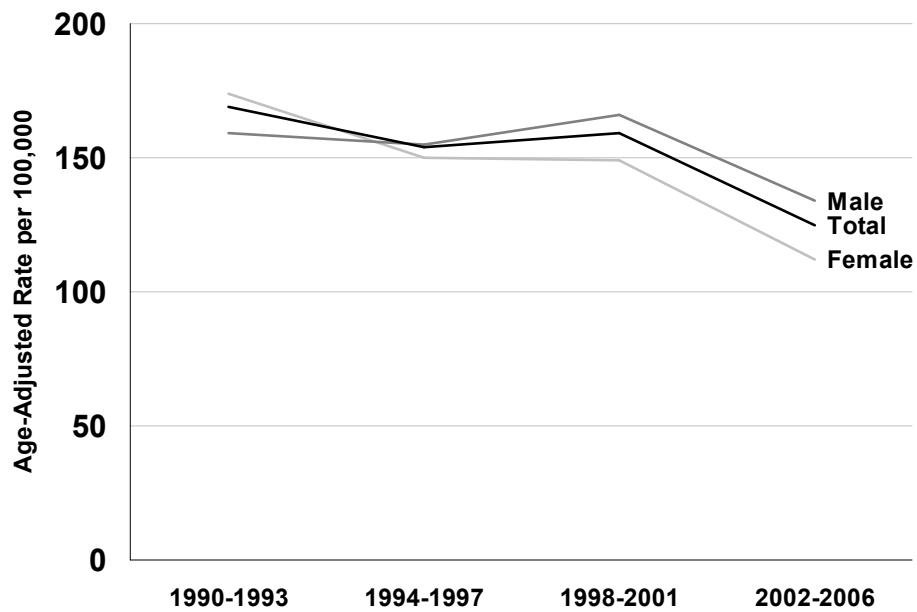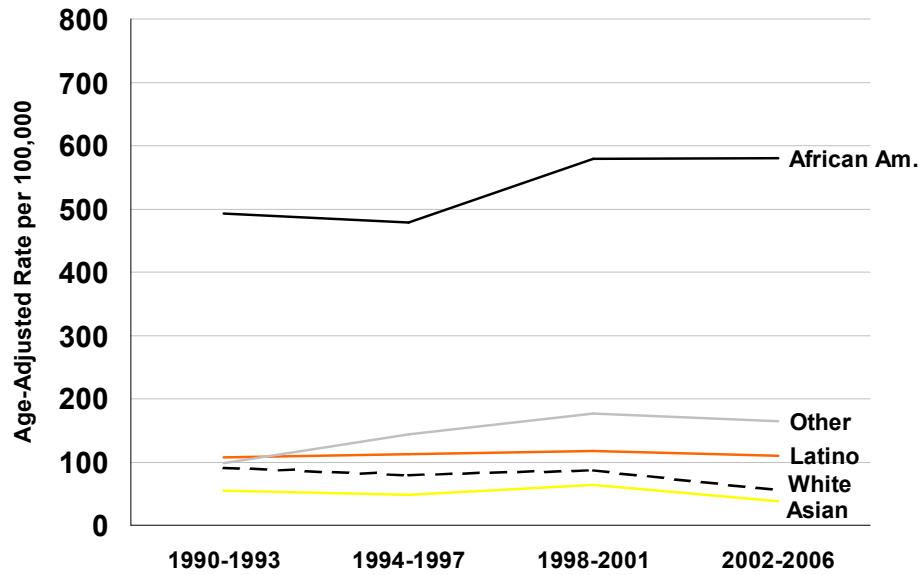Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000

Berkeley Public Health Division

Figure 3. Annual Asthma Hospitalization Rate and 95% Confidence Interval for 0 to 4 Year Olds, Berkeley, 1990-2006

Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000

Figure 4. Asthma Hospitalization Rate by Gender, Berkeley, 1990-2006

Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000

Figure 5. Asthma Hospitalization Rate by Race/Ethnicity, Berkeley, 1990-2006

Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000

Figure 6. Asthma Hospitalization Rate in 0-4 Year Olds by Race/ Ethnicity, Berkeley, 1990-2006
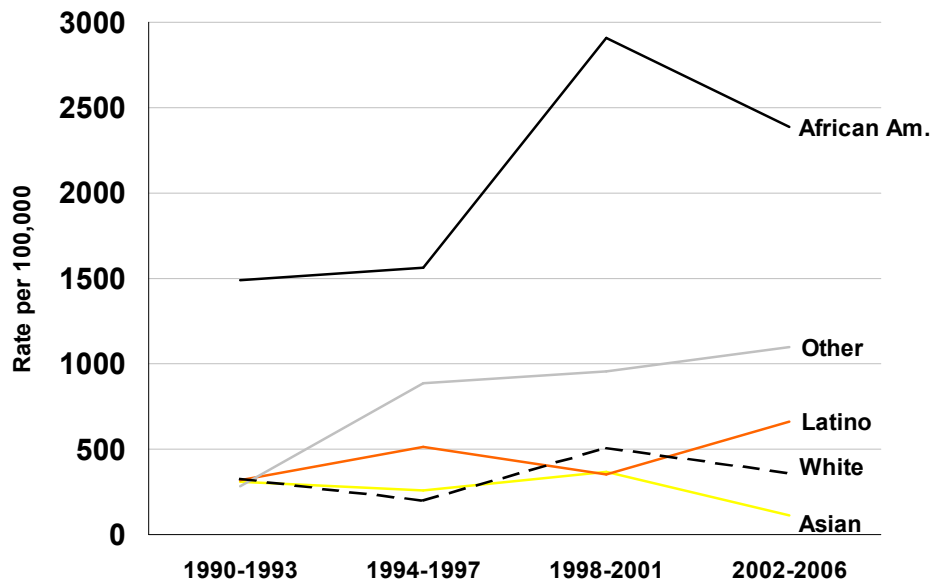
Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000
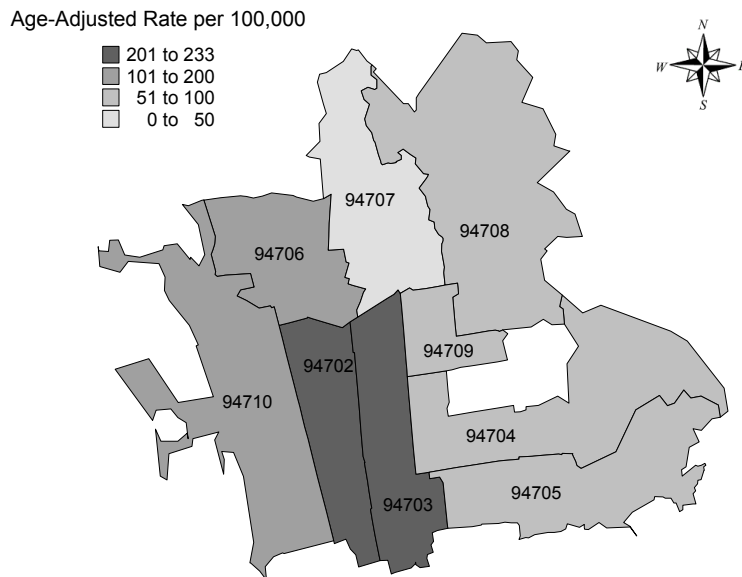
Figure 7. Asthma Hospitalization Rate by Zip Code, Berkeley, 1990-2006

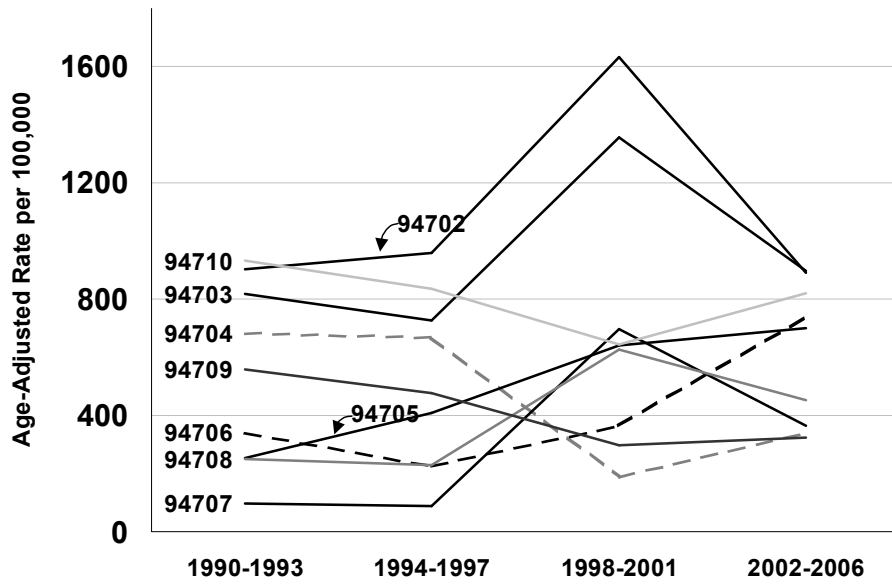Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000

Figure 8. Asthma Hospitalization Rate by Zip Code, Berkeley, All Ages, 2002-2006

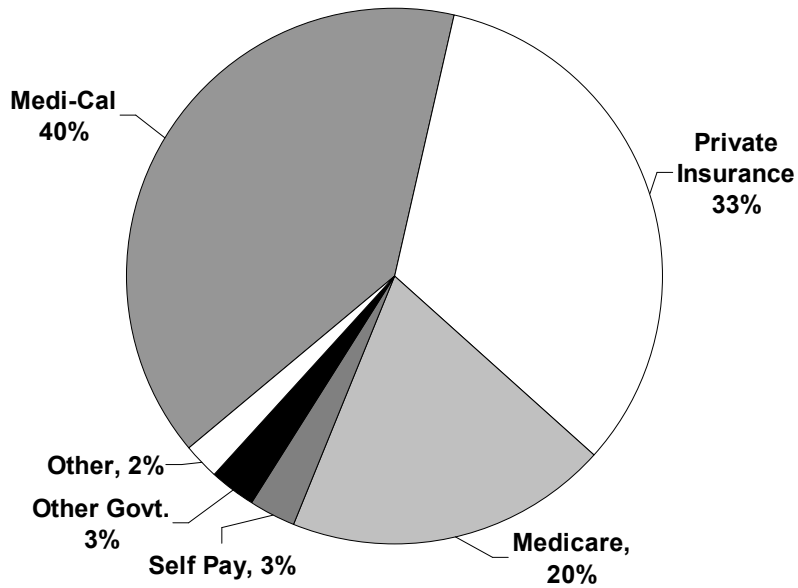Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000

Figure 9. Asthma Hospitalization Rate by Zip Code, Berkeley, 0 to 4 Year Olds, 1990-2006

Source: Office of Statewide Health Planning and Development, U.S.Census, 1990, 2000

Figure 10. Distribution of Asthma Hospitalizations by Insurance Status, Berkeley, 2002-2006

Source: Office of Statewide Health Planning and Development