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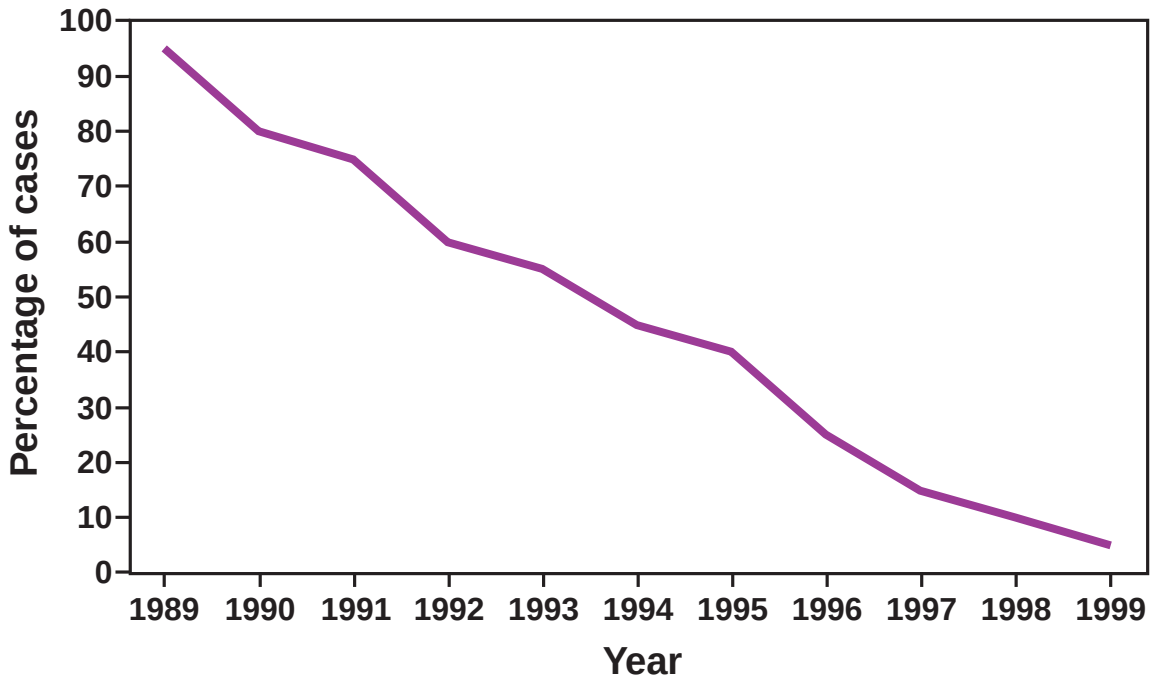
Surveillance for Asthma — United States, 1980–1999

Malaria Surveillance — United States, 1999



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CONTENTS

Surveillance for Asthma — United States, 1980–1999

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Abstract

Problem/Condition: Asthma, a chronic disease occurring among both children and adults, has been the focus of clinical and public health interventions during recent years. In addition, CDC has outlined a strategy to improve the timeliness and geographic specificity of asthma surveillance as part of a comprehensive public health approach to asthma surveillance.

Reporting Period Covered: This report presents national data regarding self-reported asthma prevalence, school and work days lost because of asthma, and asthma-associated activity limitations (1980–1996); asthma-associated outpatient visits, asthma-associated hospitalizations, and asthma-associated deaths (1980–1999); asthma-associated emergency department visits (1992–1999); and self-reported asthma episodes or attacks (1997–1999).

Description of Systems: CDC's National Center for Health Statistics (NCHS) conducts the National Health Interview Survey annually, which includes questions regarding asthma and asthma-related activity limitations. NCHS collects physician office-visit data in the National Ambulatory Medical Care Survey, emergency department and hospital outpatient data in the National Hospital Ambulatory Medical Care Survey, hospitalization data in the National Hospital Discharge Survey, and death data in the Mortality Component of the National Vital Statistics System.

Results: During 1980–1996, asthma prevalence increased. Annual rates of persons reporting asthma episodes or attacks, measured during 1997–1999, were lower than the previously reported asthma prevalence rates, whereas the rates of lifetime asthma, also measured during 1997–1999, were higher than the previously reported rates. Since 1980, the proportion of children and adults with asthma who report activity limitation has remained stable. Since 1995, the rate of outpatient visits and emergency department visits for asthma increased, whereas the rates of hospitalization and death decreased. Blacks continue to have higher rates of asthma emergency department visits, hospitalizations, and deaths than do whites.

Interpretation: Since the previous report in 1998 (*CDC. Surveillance for Asthma — United States, 1960–1995. MMWR 1998;47[No. SS-1]:1–28*), changes in asthma-associated morbidity and death have been limited. Asthma remains a critical clinical and public health problem. Although data in this report indicate certain early indications of success in current asthma intervention programs (e.g., limited decreases in asthma hospitalization and death rates), the continued presence of substantial racial disparities in these asthma endpoints highlights the need for continued surveillance and targeted interventions.

Introduction

Asthma is a prevalent chronic illness in the United States that has been increasing in prevalence since 1980 (*1*). During 1991–2001, the problem of asthma has been the focus of programs and reports from governmental agencies (e.g., the National Heart Lung and Blood Institute's National Asthma Education and Prevention Program [NAEPP] [*2*] and the U.S. Department of Health and Human Services' Action Against Asthma report [*3*]) and nongovernmental commissions (e.g., the Pew Environmental Health Commission's Attack Asthma report [*4*]). A common feature of these reports and programs is a call for improved asthma surveillance.

Asthma is a key component of the Healthy People 2010 objectives (*5*). Eight objectives address asthma: 24-1, reduce asthma deaths; 24-2, reduce hospitalizations for asthma; 24-3, reduce hospital emergency department visits for asthma; 24-4, reduce activity limitations among persons with asthma; 24-5, reduce the number of school or work days missed by persons with asthma because of their asthma; 24-6, increase the proportion of persons with asthma who receive formal patient education, including information regarding commu-

nity and self-help resources, as an essential part of the management of their condition; 24-7, increase the proportion of persons with asthma who receive appropriate asthma care according to the NAEPP guidelines; and 24-8, establish in ≥25 states a surveillance system for tracking asthma deaths, illnesses, disabilities, impact of occupational and environmental factors on asthma, access to medical care, and asthma management (*5*).

In 1998, CDC reported on the morbidity and mortality related to asthma for 1960–1995 (*1*). The findings from that report included increasing trends of asthma prevalence and mortality, as well as racial and regional disparities in asthma emergency department visits, asthma hospitalizations, and asthma deaths. In addition, CDC outlined a strategy to improve the timeliness and geographic specificity of asthma surveillance as part of a comprehensive public health approach to asthma. Since the publication of the 1998 report, which included data through 1995, progress has been made in implementing this surveillance strategy.

This report presents national data regarding self-reported asthma prevalence, school and work days lost because of asthma, and asthma-associated activity limitations (1980–1996); asthma-associated outpatient visits, asthma-associated hospitalizations, and asthma-associated deaths (1980–1999); asthma-associated emergency department visits (1992–1999); and self-reported asthma episodes or attacks (1997–1999). This report also describes progress made toward developing and improving surveillance for asthma at the state and local level.

Methods

We used data from national health surveys conducted by CDC's National Center for Health Statistics (NCHS) to measure asthma prevalence, asthma episodes or attacks, asthma-associated school and work absence days, asthma-associated activity limitation, asthma physician office and hospital outpatient department visits, asthma emergency department visits, asthma hospitalizations, and asthma deaths nationally. For the latter three measures, we determined rates in four regions of the United States,* which are geographic divisions defined by the U.S. Bureau of the Census (Figure 1). We used population estimates from the U.S. Bureau of the Census as denominators for asthma office-visit rates, asthma emergency department visits, asthma hospitalizations, and asthma deaths. We used the civilian, noninstitutionalized population of the United States as our denominator for prevalence rates and asthma episode or attack rates. We stratified each population denominator data set by region, sex, race (white, black, and other), and age group (0–4 years, 5–14 years, 15–34 years, 35–64 years, and ≥65 years). For determination of asthma-associated activity limitation and asthma-associated school absence or work loss, we used two age strata, 5–17 years and ≥18 years. In this report, we list annual estimates in the tables for selected years (i.e., 1980, 1985, 1990, and 1995–1999) and annual estimates for 1980–1999 in the figures for every measure except asthma-associated activity limitation, school absence, and work loss. For those estimates, we had to group years because the denominator (i.e., persons with asthma) in the surveys was smaller.

Our results were age-adjusted to the 2000 U.S. population by using five age groups (i.e. 0–4 years, 5–14 years, 15–34 years, 35–64 years, and ≥65 years). Regional emergency department data and death data were age-, sex- and race-adjusted. We analyzed all data by using SAS (version 6) (*6*) and SUDAAN (version 7.5) (*7*). We used two-tailed t-tests to determine whether the differences between two points in time in asthma prevalence rates, asthma physician office-visit and hospital outpatient department rates, asthma emergency department visit rates, asthma hospitalization rates, and asthma death rates were statistically significant. We used two-tailed t-tests to compare asthma hospitalization rates and asthma emergency department visit rates between regions, racial groups, age groups, and males and females. By using the Bonferroni adjustment technique for multiple comparisons in ≤5 groups, we considered a familywide p-value of 0.05 as statistically significant.

Prevalence and Attacks or Episodes

NCHS conducts the National Health Interview Survey (NHIS) annually among a probability sample of the civilian, noninstitutionalized population of the United States (*8*). Before 1997, for one-sixth of the NHIS-sampled households (i.e., approximately 20,000 of 120,000 persons), participants were asked whether they had any one of 17 chronic respiratory conditions, including asthma, during the preceding 12 months. Under this design, information regarding asthma among adults might not have been reported by the subjects themselves. For children aged <18 years, a knowledgeable adult family member, usually a parent, acted as a proxy respondent. Asthma prevalence was determined if a positive response was given to the following question: "During the past 12 months, have you had asthma?"

* **Northeast:** Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. **Midwest:** Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. **South:** Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. **West:** Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Starting in 1997, NHIS collected information regarding asthma for a randomly selected sample child (i.e., by using a proxy respondent) in every household having a child and for a randomly selected adult in each household. Asthma attacks or episodes in the previous year were determined if positive responses were given to the following questions: "Has a doctor or other health professional ever told you that you had asthma?" and "During the past 12 months, have you had an episode of asthma or an asthma attack?" (*8,9*). We used SUDAAN to determine relative standard errors (RSEs) of the estimates and indicate which estimates had RSEs of <30%, indicating relatively high reliability (*7*).

School and Work Absence Days and Activity Limitation

Through 1996, NHIS provided data regarding days of school and work missed and activity limitations resulting from specific conditions. The number of asthma-associated school absence days in the previous 2 weeks was collected for children aged 6–16 years during 1980–1982, and for those aged 5–17 years during 1985–1996. The number of asthma-associated work absence days for the previous 2 weeks was collected for persons aged ≥17 years in 1980–1982 and ≥18 years for 1985–1996. Because NHIS is conducted continuously throughout the year, no seasonal bias exists in the 2-week recall period when that period information is aggregated for the entire annual sample. Survey weights were used to aggregate the number of absence days reported in the 2-week recall period during a 1-year period. We calculated the rate of absence days per person-asthma–year (i.e., person-year among all persons with asthma) and the percentage of those with asthma who had ≥1 absence days in the previous 2 weeks. Because of the relatively limited number of persons reporting absence days in the previous 2 weeks for each survey year, we used multiple years of data to obtain stable estimates for absence days.

Activity limitation questions measured ability to perform age-appropriate activities. The percentage of persons with asthma who reported asthma-associated activity limitation was calculated for children aged 5–17 years and adults aged ≥18 years who reported being currently employed. Activity limitations were classified into one of four groups: all major activity was limited; certain major activities were limited; other activities were limited; or no activities were limited. For children aged 5–17 years, major activity was defined as school attendance, and for employed adults aged ≥18 years, as working. Respondents were categorized as limited if they reported limitations in major or other activities and if asthma was identified as the primary or secondary cause of the limitation.

Physician Office Visits, Hospital Outpatient Department Visits, and Emergency Department Visits

Ambulatory medical care is the predominant means of providing health-care services in the United States. In this report, we consider both physician office visits and hospital outpatient department visits, the data for which are collected by using different surveys, as office visits; we consider emergency department visits separately. Physician office-visit data were collected through the National Ambulatory Medical Care Survey (NAMCS), which NCHS administered in 1973–1981, 1985, and annually since 1989 (*10*). Approximately 2,000 physicians participated each year, reporting data regarding approximately 30,000 patient encounters. Hospital outpatient department visit data and emergency department visit data were collected by using the National Hospital Ambulatory Medical Care Survey (NHAMCS), which has been administered annually since 1992 (*11*). Approximately 500 hospitals are sampled each year, resulting in approximately 30,000 outpatient department encounters and 30,000 emergency department encounters.

For both data sets, we identified all patient visits for which asthma (*International Classification of Diseases*, 9th Revision, code 493) (*12*) was the first listed diagnosis. Sample weights were used to obtain national estimates of annual outpatient (i.e., physician office and hospital outpatient department) visits and emergency department visits for asthma. We used the RSEs, which are listed with the database documentation, to determine which estimates had RSEs of <30%, indicating relatively high reliability (*13*).

Hospitalizations

The National Hospital Discharge Survey (NHDS), conducted annually by NCHS since 1965, is a national survey of approximately 275,000 patient records from approximately 500 nonfederal general and short-stay specialty hospitals. A hospitalization for asthma was defined as a primary discharge diagnosis of asthma (ICD-9 code 493) (*12*). Race was missing for 5%–20% of the sample in any given year (*14*). We excluded these persons from the race-specific rate calculations but included them in all of the other rate calculations. We used published relative standard errors (*13*) to indicate which estimates had RSEs of <30%, indicating relatively high reliability.

Mortality

The Mortality Component of the National Vital Statistics System includes medical conditions and demographic characteristics reported on death certificates (*15*). We searched

for deaths for which asthma was the underlying cause of death (ICD-9 code 493 for 1980–1998 and ICD-10 codes J45–J46 for 1999), (*12,16*) and calculated standard errors (i.e., the square root of the inverse of the number of deaths) because the number of asthma deaths is limited and annual rates are subject to random variation. The comparability ratio for asthma from ICD-9 to ICD-10 is 0.89, which means that 89% of the deaths classified as being caused by asthma under the ICD-9 classification would be classified as asthma deaths under the ICD-10 classification (*15*).

Results

Prevalence and Episodes or Attacks

The self- or proxy-reported 12-month prevalence of asthma increased 73.9% during 1980–1996, with an estimated 14.6 million persons (54.6/1,000 population) reporting asthma during the previous 12 months in 1996 (Table 1; Figure 2). Beginning in 1997, the asthma questions on NHIS changed the measures of asthma prevalence (*9*). Now, two measures are used, both restricted to persons with a medical diagnosis of asthma. The first is referred to as lifetime asthma prevalence, which includes those respondents with a medical diagnosis of asthma at anytime in the their lives. In 1997, a total of 26.7 million persons (96.6/1,000 population) reported a physician diagnosis of asthma during their lifetime, which is substantially higher than the 12-month prevalence measured before 1997 (Figure 2). The second measure is a 12-month attack prevalence, which includes the number of persons with asthma who have had ≥1 attacks or episodes in the past 12 months. In 1997, the estimated prevalence of persons with asthma episodes or attacks was 11.1 million (40.7/1,000 population), lower than the 12-month prevalence estimated from the question wording used before 1997 (Tables 1,2; Figure 2). A sufficient number of years with the new measures do not yet exist to determine whether the trends in asthma are increasing or decreasing. Both 12-month prevalence (before 1997) and 12-month attack prevalence of asthma (since 1997) were higher among children aged 5–14 years, blacks compared with whites, and females. Neither 12-month prevalence nor episodes or attacks of asthma varied substantially among regions of the United States (data not indicated).

Absence Days and Activity Limitation

School absence days among children and work absence days among adults increased from 1980–82 to 1995–96 (Table 3). During 1980–1996, rates of school absence per child with asthma per year and the percentage of children with asthma who had limited activity because of asthma decreased slightly (4.9%–3.7%). Also not statistically significant, the percentage of children missing ≥1 days of school in the previous 2 weeks decreased during the same period. Work absence days among adults with asthma demonstrated similar trends to school absence days among children with asthma, except the percentage of adults missing ≥1 days of work because of asthma in the previous 2 weeks increased slightly during 1990–1996, although the change was not statistically significant.

Physician Office and Hospital Outpatient Department Visits

During 1980–1999, the number of office visits for asthma as the primary diagnosis increased from 5.9 million to 10.8 million (Table 4; Figure 3). During 1992–1999, this estimate included both physician office visits and hospital outpatient department visits, with the latter category including approximately 1 million visits annually. The demographic pattern in rates of office visits for asthma demonstrated higher rates among blacks, females, and children (Table 5). Office-visit rates did not vary among regions of the country (these data not included in Table 5).

Emergency Department Visits

During 1992–1999, the number of emergency department visits for asthma increased 36%, varying by region, and the rate of emergency department visits for asthma increased 29% (Tables 6,7; Figure 4). The rates for blacks were >3 times the rates for whites, and the youngest children consistently had the highest rates (Table 7).

Hospitalizations

The hospitalization rate for asthma peaked in the mid-1980s and has gradually declined since then (Tables 8,9; Figure 5). The substantial regional differences that were previously described (*1*) have persisted, as did higher rates among blacks, women, and children.

Deaths

The number of deaths and death rates from asthma increased gradually during 1980–1995 (Tables 10,11; Figure 6). Although a determination with certainty cannot be made, data for 1996–1998 indicate that mortality rates are starting to plateau or decrease. The data from 1999 cannot be directly compared with the data from previous years because of the change in the classification system from ICD-9 to ICD-10 (*13*). As noted in the previous report, disparities persist, with higher mortality rates documented among blacks, women, and the elderly, along with regional differences (Figure 6).

Discussion

The trend of increasing asthma-associated morbidity and mortality that occurred during 1980–1995 (*1*) has not continued for all measures. During 1995–1998, the rate of both physician office or hospital outpatient visits and emergency department visits for asthma increased, whereas the rate of hospitalization and death decreased. Blacks continued to have higher rates of asthma emergency department visits, hospitalizations, and deaths than did whites. Although 12-month asthma prevalence increased during 1980–1996, annual rates of asthma episodes or attacks among persons with a medical diagnosis of asthma, measured during 1997–1999, are lower than the 12-month asthma prevalence determined previously. The corresponding measures of lifetime asthma prevalence, also measured during 1997–1999, were higher than the 12-month asthma prevalence.

New in this report is the estimated morbidity of asthma as determined by missed days of school and work. During 1980–1996, the number of asthma-associated work absence days and school absence days caused by asthma have increased >50%, from 6.2 to 14.0 million for work absence days and from 6.6 to 14.0 million for school absence days. This corresponds to the increase in prevalence, because the school absence days per child with asthma and the work absence days per adult with asthma have not changed during this period.

The data in this report are useful for health departments and researchers as a comparison with the morbidity and mortality attributable to asthma among the populations they study. Populations with asthma morbidity higher than the national values might require targeted intervention programs. Although these data address Healthy People 2010 goals, certain ones (e.g., objective 24-6, increase the proportion of persons with asthma who receive formal patient education, including information regarding community and self-help resources, as an essential part of the management of their condition and objective 24-7, increase the proportion of persons with asthma who receive appropriate asthma care [*5*], according to the NAEPP guidelines) will require different surveys.

In our previous report, we noted such limitations as a lack of data (other than death data) at the state or local level and the timeliness of these data. Although these barriers still exist, progress is being made. In 2000, the Behavioral Risk Factor Surveillance System (BRFSS), an ongoing random-digit–dialed telephone survey used in all 50 states, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands, added two questions regarding asthma prevalence to the core survey. These data indicate variation in prevalence among the participating sites. Lifetime asthma prevalence varied from a low of 8.0% in Louisiana to a high of 15.9% in Puerto Rico. Current asthma prevalence varied from a low of 5.0% in Louisiana to a high of 8.9% in Maine (*17*). In addition, local health departments have been successful in using existing data to determine patterns in asthma morbidity and, subsequently, target interventions (*18*).

New methods are being developed for asthma surveillance, including determining incident cases of asthma by using such sites as emergency departments to capture information regarding persons with asthma and to gain a better understanding of the factors related to asthma deaths (*4*). In 2000, CDC funded a program to implement asthma surveillance and interventions in hospital emergency departments and to evaluate the surveillance and effectiveness of these interventions in reducing subsequent asthma hospitalizations and emergency department visits. Michigan State University and the University of South Carolina have been awarded cooperative agreements for a 3-year period to work with selected hospital emergency departments serving diverse populations. A second CDC initiative begins planning for population-based surveillance for asthma incidence. Asthma surveillance sites will be population-based centers designed to assess the public health impact of asthma, to determine asthma incidence, and to identify population-based risk factors associated with asthma onset.

A third CDC initiative demonstrates the feasibility of a rapid asthma death notification system among persons aged 2–34 years. This will include investigations of the asthma-associated deaths identified and will describe the circumstances of these deaths to determine whether and how such deaths could have been prevented.

Diagnosing asthma remains challenging. Although the clinical definition of asthma is the presence of variable airflow obstruction that reverses either spontaneously or with treatment, differentiating asthma from other chronic obstructive lung diseases remains difficult, chiefly among preschool and older adult populations. Using surveys (e.g., those in this report) has additional limitations. For example, the majority of the asthma estimates contained in this report are dependent on physicians accurately diagnosing and documenting asthma in patient records, with the potential for either underestimates or overestimates of cases. Estimates of asthma prevalence, in addition, require the subjects to recall the physician's diagnosis and are subject to similar biases. The Council of State and Territorial Epidemiologists has developed a case definition for asthma for use in epidemiologic studies of asthma and asthma surveillance that provides definition uniformity (*19*).

Asthma remains a key public health problem in the United States. This report does not indicate dramatic changes in asthma morbidity or mortality since our 1998 report (*1*), although

the downward trend in asthma hospitalizations and asthma mortality might indicate early successes by asthma intervention programs since 1991 (*2*). A gradual but consistent upward trend occurred in 12-month asthma prevalence during 1980–1996; however, the major changes in question wording in 1997 make forming conclusions regarding the trend since that time impossible. Although a numeric increase has occurred in the numbers and rates of physician office or hospital outpatient department visits and emergency department visits, these increases are accounted for by the increase in prevalence. Opportunities to improve our understanding of this disease and decrease its substantial morbidity in the United States remain. Public health programs must continue to provide scientifically validated programs to improve provider and patient adherence to published guidelines for treating asthma.

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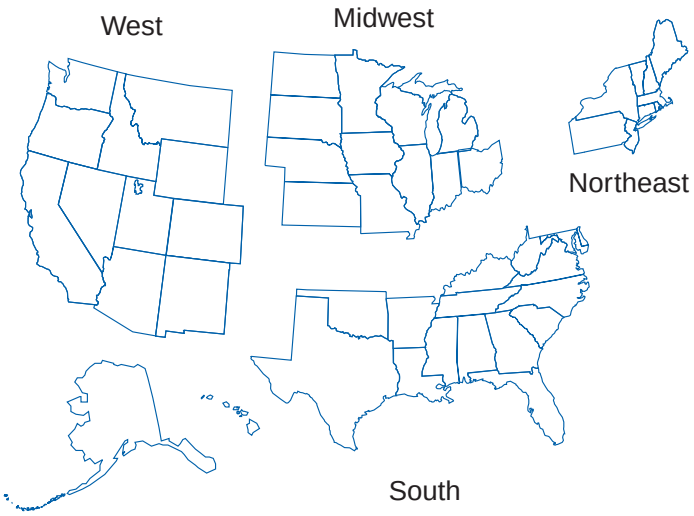
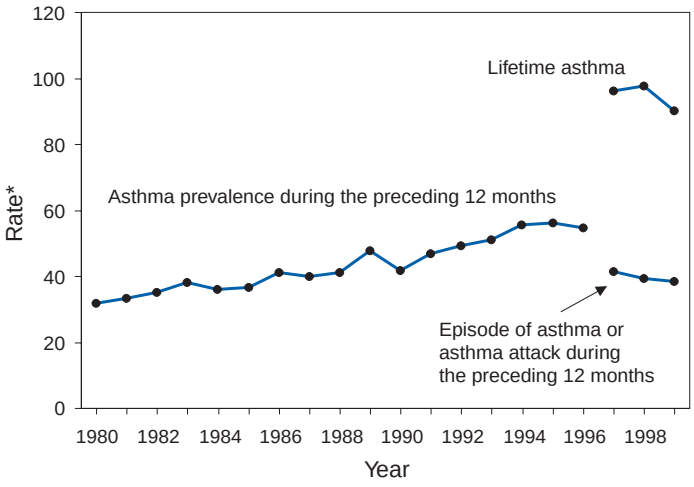
FIGURE 1. Geographical regions of the United States* as used in this report



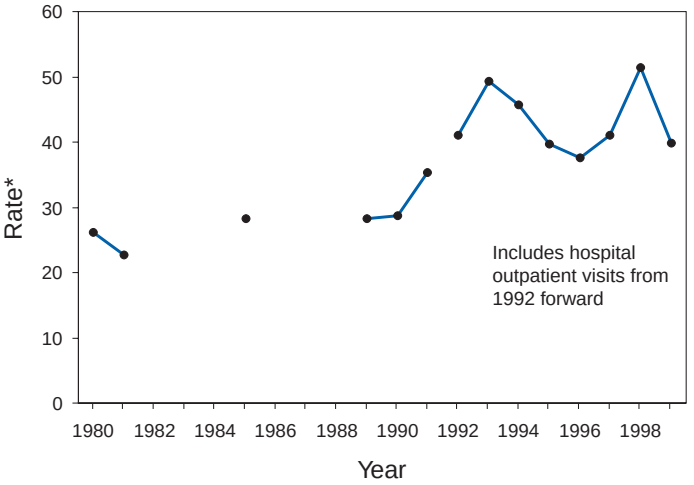
* The four U.S. geographic regions defined by the U.S. Bureau of the Census are **Northeast:** Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. **Midwest:** Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. **South:** Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. **West:** Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

FIGURE 2. Estimated annual prevalence* of asthma — United States, National Health Interview Survey, 1980–1999



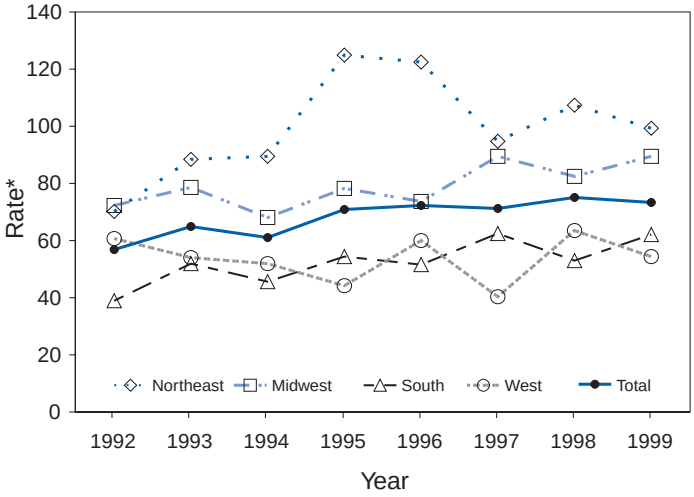
* Per 1,000 population; age-adjusted to the 2000 U.S. population.

FIGURE 3. Estimated annual rate* of office visits for asthma as the first-listed diagnosis, National Ambulatory Medical Care — United States, 1980–1999 and National Hospital Ambulatory Medical Care Survey — United States, 1992–1999



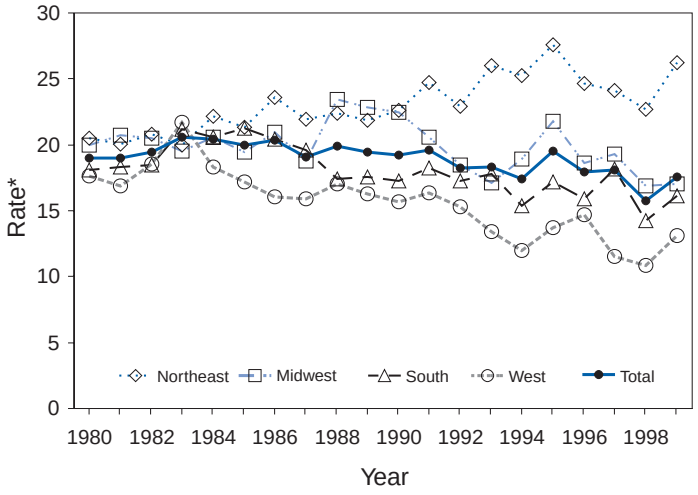
* Per 1,000 population; age-adjusted to the 2000 U.S. population.

FIGURE 4. Estimated annual rate* of emergency department visits for asthma as the first-listed diagnosis, by region and year, National Hospital Ambulatory Medical Care Survey — United States, 1992–1999



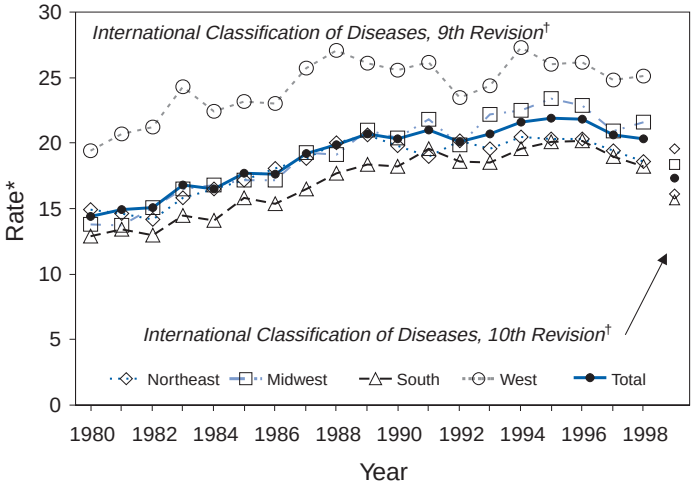
* Per 10,000 population; age-adjusted to the 2000 U.S. population.

FIGURE 5. Estimated annual rate* of hospitalizations for asthma as the first-listed diagnosis, by region and year, National Hospital Discharge Survey — United States, 1980–1999



* Per 10,000 population; age-adjusted to the 2000 U.S. population.

FIGURE 6. Annual rate* of death for asthma as the underlying cause of death, by region and year, Mortality Component of the National Vital Statistics System — United States, 1980–1999



* Per 1,000,000 population; race-, sex-, and age-adjusted to the 2000 U.S. population.

† World Health Organization. Manual of the international statistical classification of diseases, injuries, and causes of death. 10th revision. Geneva, Switzerland: World Health Organization, 1999.

TABLE 1. Estimated annual number of persons with self-reported asthma (1980–1996) or an episode of asthma or asthma attack (1997–1999) during the preceding 12 months, by race, sex, and age group, National Health Interview Survey — United States, 1980–1999*

	1980	1985	1990	1995	1996	1997	1998	1999
	Self-reported asthma prevalence during the preceding 12 months					Episode of asthma or asthma attack during the preceding 12 months		
Race								
White	5,975,000	7,425,000	8,544,000	12,161,000	11,764,000	8,924,000	8,352,000	8,226,000
Black	899,000	1,119,000	1,413,000	2,217,000	2,310,000	1,629,000	1,680,000	1,535,000
Other	102,000†	68,000†	353,000	461,000	522,000	559,000	581,000	727,000
Sex								
Male	3,438,000	3,863,000	4,741,000	6,673,000	5,751,000	4,592,000	4,550,000	4,310,000
Female	3,538,000	4,748,000	5,570,000	8,166,000	8,845,000	6,522,000	6,063,000	6,178,000
Age group (yrs)								
0–4	369,000	661,000	840,000	1,227,000	805,000	812,000	915,000	825,000
5–14	1,530,000	1,720,000	2,270,000	3,215,000	2,771,000	2,391,000	2,321,000	2,288,000
15–34	2,251,000	2,855,000	2,898,000	4,443,000	5,139,000	3,380,000	2,853,000	3,208,000
35–64	2,056,000	2,339,000	3,220,000	4,715,000	4,441,000	3,655,000	3,599,000	3,451,000
≥65	769,000	1,036,000	1,082,000	1,238,000	1,445,000	875,000	925,000	717,000
Total§	**6,975,000**	**8,611,000**	**10,310,000**	**14,838,000**	**14,601,000**	**11,113,000**	**10,613,000**	**10,488,000**

* All relative standard errors are <30%, unless otherwise indicated.

† Relative standard error of the estimate is 30%–50%; the estimate is unreliable.

§ Numbers for each variable might not add up to total because of rounding error.

TABLE 2. Estimated annual prevalence* of self-reported asthma (1980–1996) or an episode of asthma or asthma attack (1997–1999) during the preceding 12 months, by race, sex and age group, National Health Interview Survey — United States, 1980–1999†

	1980	1985	1990	1995	1996	1997	1998	1999
	Self-reported asthma prevalence during the preceding 12 months					Episode of asthma or asthma attack during the preceding 12 months		
Race§								
White	31.4	37.0	41.5	54.5	53.6	40.5	37.5	37.6
Black	33.1	38.6	45.8	64.8	65.5	45.4	46.7	42.7
Other	19.9¶	12.8¶	40.2	44.4	43.2	34.7	33.7	38.9
Sex§								
Male	30.5	33.8	39.1	48.6	43.0	33.0	31.7	31.6
Female	31.9	38.9	44.2	61.1	65.5	47.9	44.4	44.5
Age group (yrs)								
0–4	23.0	36.7	44.0	60.5	40.1	41.2	46.4	42.1
5–14	45.1	50.9	63.7	82.0	69.8	60.0	57.8	56.4
15–34	30.0	36.1	37.3	57.8	67.2	44.2	37.5	42.2
35–64	29.9	30.8	38.4	50.1	46.2	37.0	35.7	33.4
≥65	31.9	38.6	36.3	39.4	45.5	27.3	28.7	22.1
Total§	**31.4**	**36.6**	**41.9**	**55.2**	**54.6**	**40.7**	**39.2**	**38.4**

* Per 1,000 population.
† All relative standard errors are <30%, unless otherwise indicated.
§ Age-adjusted to 2000 U.S. population.
¶ Relative standard error of the estimate is 30%–50%; the estimate is unreliable.

TABLE 3. Estimated average annual number of school and work absence days related to asthma, percentage with ≥1 absence days in the previous 2 weeks, and activity limitation caused by asthma among children aged 5–17 years and adults aged ≥18 years with self-reported asthma during the preceding 12 months, National Health Interview Survey — United States, 1980–1996

	1980–82*	1985–87	1990–92	1994–96
Children aged 5–17 years with proxy-reported asthma				
School absence days (millions)	6.6	11.4	14.6	14.0
School absence days per child-asthma-year	4.9	4.4	4.7	3.7
Percentage with ≥1 absence days in the previous 2 weeks	8.0%	8.1%	7.7%	5.4%
Percentage with activity limitation caused by asthma	27.2%	20.3%	27.6%	23.6%
Adults aged ≥18 years with self-reported asthma†				
Work absence days (millions)	6.2	3.8	10.7	14.5
Work absence days per adult-asthma-year	2.4	1.1	2.5	2.5
Percentage with ≥1 absence days in the previous 2 weeks	2.5%	2.5%	2.1%	3.3%
Percentage with activity limitation caused by asthma	14.4%	13.9%	15.7%	14.6%

* Age groups for these years for school absence days are 6–16 years, and for work absence days, persons aged ≥17 years.
† Includes only adults who report being employed at the time of the survey.

TABLE 4. Estimated annual number of physician office visits (1980–1999) and hospital outpatient department visits (1995–1999) for asthma as the first-listed diagnosis, by race, sex, and age group, National Ambulatory Medical Care Survey — United States, 1980–1999 and National Hospital Ambulatory Medical Care Survey — United States, 1995–1999*

	1980	1985	1990	1995	1996	1997	1998	1999
Race								
White	5,234,000	5,663,000	5,386,000	8,241,000	8,107,000	8,664,000	10,274,000	8,810,000
Black	648,000†	702,000	1,059,000	1,500,000	1,464,000	1,707,000	2,661,000	1,478,000
Other	—§	—§	692,000†	586,000†	383,000†	559,000†	918,000	520,000
Sex								
Male	2,659,000	2,972,000	2,574,000	3,508,000	3,863,000	5,160,000	5,921,000	4,827,000
Female	3,262,000	3,532,000	4,563,000	6,820,000	6,091,000	5,770,000	7,932,000	5,981,000
Age group (yrs)								
0–4	530,000†	556,000	881,000	1,094,000	1,337,000	1,458,000	1,807,000	1,150,000
5–14	1,760,000	1,520,000	1,271,000	2,163,000	2,044,000	2,158,000	3,507,000	2,387,000
15–34	1,469,000	1,206,000	1,723,000	1,977,000	2,177,000	2,255,000	2,726,000	1,960,000
35–64	1,475,000	2,275,000	2,012,000	3,680,000	2,970,000	3,573,000	4,283,000	4,069,000
≥65	687,000	945,000	1,251,000	1,413,000	1,427,000	1,486,000	1,530,000	1,243,000
Total¶	**5,921,000**	**6,503,000**	**7,138,000**	**10,327,000**	**9,955,000**	**10,930,000**	**13,853,000**	**10,808,000**

* All relative standard errors are <30%, unless otherwise indicated.
† Relative standard error of the estimate is 30%–50%; the estimate is unreliable.
§ Relative standard error of the estimate exceeds 50%.
¶ Numbers for each variable might not add up to total because of rounding error and missing race data for 1990.

TABLE 5. Estimated annual rate* of physician office visits (1980–1999) and hospital outpatient department visits (1995–1999) for asthma as the first-listed diagnosis, by race, sex, and age group, National Ambulatory Medical Care Survey — United States, 1980–1999 and National Hospital Ambulatory Medical Care Survey — 1995–1999†

	1980	1985	1990	1995	1996	1997	1998	1999
Race§								
White	26.9	28.8	25.8	38.3	37.2	39.5	46.6	39.6
Black	22.8¶	27.8	35.6	47.2	40.0	47.7	76.4	41.9
Other	—**	—**	83.0¶	57.2¶	31.0¶	55.1¶	68.8	36.8
Sex§								
Male	23.9	26.5	21.2	27.5	29.8	39.4	44.3	36.6
Female	27.9	29.6	35.8	51.1	45.0	42.1	57.8	43.4
Age group (yrs)								
0–4	32.4¶	31.7¶	47.0	58.0	70.8	77.1	95.4	60.6
5–14	50.4	43.4	36.2	57.6	53.7	56.0	90.0	60.4
15–34	18.5	15.1	21.5	25.4	28.2	29.4	35.7	25.9
35–64	21.0	29.6	24.1	38.9	30.7	36.1	42.3	39.3
≥65	26.9	33.4	40.3	43.0	42.9	44.2	45.0	36.2
Total§	**26.1**	**28.3**	**28.8**	**39.8**	**37.7**	**41.0**	**51.5**	**39.8**

* Per 1,000 population.
† All relative standard errors are <30%, unless otherwise indicated.
§ Age-adjusted to 2000 U.S. population.
¶ Relative standard error of the estimate is 30%–50%; the estimate is unreliable.
** Relative standard error of the estimate exceeds 50%.

TABLE 6. Estimated annual number of emergency department visits for asthma as the first-listed diagnosis, by race, sex, and age group, National Hospital Ambulatory Medical Care Survey — United States, 1992–1999*

	1992	1995	1996	1997	1998	1999
Race						
White	925,000	1,018,000	1,186,000	1,263,000	1,278,000	1,313,000
Black	488,000	775,000	680,000	619,000	697,000	630,000
Other	54,000†	73,000†	69,000†	—§	59,000†	54,000
Sex						
Male	667,000	725,000	968,000	808,000	908,000	932,000
Female	800,000	1,140,000	967,000	1,109,000	1,126,000	1,065,000
Age group (yrs)						
0–4	288,000	248,000	326,000	327,000	322,000	269,000
5–14	291,000	322,000	359,000	341,000	444,000	389,000
15–34	438,000	566,000	653,000	664,000	659,000	616,000
35–64	361,000	630,000	510,000	490,000	504,000	601,000
≥65	89,000	101,000	86,000	95,000	105,000	122,000
Total¶	**1,467,000**	**1,867,000**	**1,934,000**	**1,917,000**	**2,034,000**	**1,997,000**

* All relative standard errors are <30% unless otherwise indicated.
† Relative standard error of the estimate is 30%–50%; the estimate is unreliable.
§ Relative standard error of the estimate exceeds 50%.
¶ Numbers for each variable might not add up to total because of rounding error.

TABLE 7. Estimated annual rate* of emergency department visits for asthma as the first-listed diagnosis, by race, sex, and age group, National Hospital Ambulatory Medical Care Survey — United States, 1992–1999†

	1992	1995	1996	1997	1998	1999
Race§						
White	43.7	46.9	54.6	57.7	58.2	59.4
Black	143.2	226.4	188.7	171.2	183.7	174.3
Other	49.3§	56.2¶	56.2¶	—**	45.8¶	38.4
Sex§						
Male	51.7	54.4	71.9	59.5	66.7	68.6
Female	61.5	85.9	72.0	81.8	82.3	77.2
Age group (yrs)						
0–4	153.0	131.2	172.6	177.8	170.2	141.8
5–14	80.6	85.8	94.4	88.6	113.8	98.5
15–34	55.3	72.7	84.6	86.5	86.4	81.3
35–64	41.0	66.5	52.7	49.4	49.8	58.1
≥65	28.0	28.7	25.8	28.3	30.9	35.5
Total§	**56.8**	**70.7**	**72.4**	**71.2**	**75.1**	**73.3**

* Per 10,000 population.
† All relative standard errors are <30%, unless otherwise indicated.
§ Age-adjusted to 2000 U.S. population.
¶ Relative standard error of the estimate is 30%–50%; the estimate is unreliable.
** Relative standard error of the estimate exceeds 50%.

TABLE 8. Estimated annual number of hospitalizations for asthma as the first-listed diagnosis, by race, sex, and age group, National Hospital Discharge Survey — United States, 1980–1999*

	1980	1985	1990	1995	1996	1997	1998	1999
Race								
White	288,000	309,000	263,000	256,000	237,000	262,000	222,000	236,000
Black	73,000	91,000	116,000	140,000	133,000	125,000	115,000	128,000
Other	—†	22,000	19,000	25,000	33,000	39,000	28,000	42,000
Missing§	42,000	40,000	78,000	90,000	71,000	58,000	58,000	72,000
Sex								
Male	180,000	195,000	191,000	210,000	195,000	204,000	168,000	190,000
Female	228,000	266,000	285,000	301,000	279,000	279,000	255,321	288,000
Age group (yrs)								
0–4	61,000	84,000	104,000	118,000	114,000	121,000	90,000	105,000
5–14	63,000	61,000	65,000	94,000	81,000	93,000	76,000	85,000
15–34	67,000	77,000	75,000	80,000	73,000	70,000	56,000	77,000
35–64	133,000	143,000	140,000	142,000	147,000	135,000	141,000	138,000
≥65	84,000	97,000	90,000	77,000	59,000	65,000	60,000	73,000
Total¶	**408,000**	**462,000**	**476,000**	**511,000**	**474,000**	**484,000**	**423,000**	**478,000**

* All relative standard errors are <30%, unless otherwise indicated.
† Relative standard error of the estimate exceeds 50%.
§ Race date were not collected by certain hospitals in the survey.
¶ Numbers for each variable might not add up to total because of rounding error.

TABLE 9. Estimated annual rate* of hospitalizations for asthma as the first-listed diagnosis, by race, sex, and age group, National Hospital Discharge Survey — United States, 1980–1999†

	1980	1985	1990	1995	1996	1997	1998	1999
Race§								
White	15.6	15.8	12.6	11.8	10.9	11.9	10.1	10.6
Black	27.0	31.1	38.3	40.7	38.2	34.4	32.5	35.6
Other	—¶	29.9	22.5	22.4	26.8	29.4	21.4	31.5
Sex§								
Male	17.4	17.4	15.6	16.1	14.8	15.3	12.5	14.1
Female	20.3	22.2	22.1	22.4	20.6	20.4	18.4	20.6
Age group (yrs)								
0–4	37.3	47.8	55.6	62.6	60.2	63.9	47.3	55.4
5–14	18.1	17.3	18.5	25.0	21.3	24.1	19.6	21.5
15–34	8.5	9.7	9.4	10.2	9.4	9.1	7.3	10.1
35–64	18.9	18.6	15.5	15.0	15.2	13.7	13.9	13.4
≥65	32.8	34.4	33.0	23.5	17.7	19.3	17.8	21.1
Total§	**19.0**	**19.7**	**19.2**	**19.5**	**17.9**	**18.1**	**15.7**	**17.6**

* Per 10,000 population.
† All relative standard errors are <30%, unless otherwise indicated.
§ Age-adjusted to 2000 U.S. population.
¶ Relative standard error of the estimate exceeds 50%.

TABLE 10. Annual number of deaths with asthma as the underlying cause of death diagnosis, by race, sex, and age group, Underlying Cause of Death data set — United States, 1980–1999*

	1980†	1985	1990	1995	1996	1997	1998	1999§
Race								
White	2,291	3,026	3,696	4,208	4,110	4,002	3,947	3,328
Black	557	778	986	1,247	1,325	1,200	1,290	1,145
Other	43	76	137	182	232	232	201	184
Sex								
Male	1,292	1,551	1,885	2,079	2,075	1,986	2,000	1,620
Female	1,599	2,329	2,934	3,558	3,592	3,448	3,438	3,037
Age group (yrs)								
0–4	29	27	37	34	44	35	40	32
5–14	65	100	111	151	159	130	149	144
15–34	235	338	397	522	502	472	491	444
35–64	983	1,364	1,572	1,946	1,961	1,882	1,807	1,637
≥65	1,579	2,051	2,702	2,984	3,001	2,915	2,951	2,400
Total*	**2,891**	**3,880**	**4,819**	**5,637**	**5,667**	**5,434**	**5,438**	**4,657**

* All relative standard errors are <30%.
† Code 493 from World Health Organization. Manual of the international statistical classification of diseases, injuries, and causes of death. 9th revision. Geneva, Switzerland: World Health Organization, 1977.
§ Codes J45–J46 from World Health Organization. Manual of the international statistical classification of diseases, injuries, and causes of death. 10th revision. Geneva, Switzerland: World Health Organization, 1999.

TABLE 11. Annual rate* of deaths with asthma as the underlying cause of death diagnosis, by race, sex, and age group, Underlying Cause of Death data set — United States, 1980–1999†

	1980§	1985	1990	1995	1996	1997	1998	1999¶
Race**								
White	12.9	15.6	17.5	18.8	18.1	17.4	17.0	14.2
Black	27.6	34.8	40.9	46.2	48.0	42.5	44.7	38.7
Other	13.5	16.9	23.6	23.3	27.6	26.6	22.7	20.4
Sex**								
Male	14.7	15.9	17.8	17.9	17.7	16.6	16.5	13.1
Female	14.4	19.2	22.1	25.1	25.0	23.7	23.3	20.4
Age group (yrs)								
0–4	1.8	1.5	2.0	1.8	2.3	1.9	2.1	1.7
5–14	1.9	2.9	3.2	4.0	4.6	3.4	3.8	3.6
15–34	3.0	4.2	5.0	6.7	6.5	6.1	6.4	5.9
35–64	14.0	17.7	18.8	20.6	20.3	19.0	17.8	15.8
≥65	61.8	72.5	87.0	90.8	90.3	86.7	86.9	69.9
Total**	**14.4**	**17.7**	**20.2**	**21.9**	**21.8**	**20.6**	**20.3**	**17.2**

* Per 1,000,000 population.
† All relative standard errors are <30%.
§ Code 493 from World Health Organization. Manual of the international statistical classification of diseases, injuries, and causes of death. 9th revision. Geneva, Switzerland: World Health Organization, 1977.
¶ Codes J45–J46 from World Health Organization. Manual of the international statistical classification of diseases, injuries, and causes of death. 10th revision. Geneva, Switzerland: World Health Organization, 1999.
** Age-adjusted to the 2000 U.S. population.

Malaria Surveillance — United States, 1999

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Abstract

Problem/Condition: Malaria is caused by four species of intraerythrocytic protozoa of the genus *Plasmodium* (i.e., *P. falciparum*, *P. vivax*, *P. ovale*, or *P. malariae*). Malaria is transmitted by the bite of an infective female *Anopheles* sp. mosquito. The majority of malaria infections in the United States occur in persons who have traveled to areas with ongoing transmission. In the United States, cases can occur through exposure to infected blood products, by congenital transmission, or locally through mosquitoborne transmission. Malaria surveillance is conducted to identify episodes of local transmission and to guide prevention recommendations for travelers.

Period Covered: Cases with onset of illness during 1999.

Description of System: Malaria cases confirmed by blood films are reported to local and state health departments by health-care providers or laboratory staff. Case investigations are conducted by local and state health departments, and reports are transmitted to CDC through the National Malaria Surveillance System (NMSS). Data from NMSS serve as the basis for this report.

Results: CDC received reports of 1,540 cases of malaria with an onset of symptoms during 1999 among persons in the United States or one of its territories. This number represents an increase of 25.5% from the 1,227 cases reported for 1998. *P. falciparum*, *P. vivax*, *P. malariae*, and *P. ovale* were identified in 46.0%, 30.7%, 4.6%, and 3.6% of cases, respectively. More than one species was present in 12 patients (0.8% of total). The infecting species was unreported or undetermined in 223 (14.5%) cases. The number of reported malaria cases acquired in Africa increased 27.6% (n = 901), compared with 1998, and an increase of 2.9% (n = 246) occurred in cases acquired in Asia, compared with 1998. Cases from the Americas increased by 19.7% (n = 274) from 1998. Of 831 U.S. civilians who acquired malaria abroad, 159 (19.1%) reported that they had followed a chemoprophylactic drug regimen recommended by CDC for the area to which they had traveled. Three patients became infected in the United States, all through probable local mosquitoborne transmission. Five deaths were attributed to malaria, all caused by *P. falciparum*.

Interpretation: The 25.5% increase in malaria cases in 1999, compared with 1998, resulted primarily from increases in cases acquired in Africa and the Americas. This increase is possibly related to a change in the system by which states report to CDC, but it could also have resulted from local changes in disease transmission, increased travel to these regions, improved reporting to state and local health departments, or a decreased use of effective antimalarial chemoprophylaxis. In the majority of reported cases, U.S. civilians who acquired infection abroad were not on an appropriate chemoprophylaxis regimen for the country where they acquired malaria.

Public Health Actions: Additional information was obtained concerning the five fatal cases and the three infections acquired in the United States. The NMSS surveillance form was modified to gather more detailed information regarding compliance with prescribed chemoprophylaxis regimens. Persons traveling to a malarious area should take one of the recommended chemoprophylaxis regimens appropriate to the region of travel, and travelers should use personal protection measures to prevent mosquito bites. Any person who has been to a malarious area and who subsequently develops a fever or influenza-like symptoms should seek medical care immediately; investigation should include a blood-film test for malaria. Malaria infections can be fatal if not diagnosed and treated promptly. Recommendations concerning prevention of malaria can be obtained from CDC.

Introduction

Malaria is caused by infection with one or more of four species of *Plasmodium* (i.e., *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*) that can infect humans. The infection is transmitted by the bite of an infective female *Anopheles* sp. mosquito. Malaria infection remains a devastating global problem, with an estimated 300–500 million cases occurring annually. Forty-one percent of the world's population lives in areas where malaria is transmitted (e.g., parts of Africa, Asia, the Middle East, Central and South America, Hispaniola, and Oceania) (*1*), and 700,000–2.7 million persons die of malaria each year, 75% of them African children (*2*). In previous years, malaria was endemic throughout much of the continental United States; an estimated 600,000 cases occurred during 1914 (*3*). During the late 1940s, a combination of improved socioeconomic conditions, water management, vector-control efforts, and case management was successful at interrupting malaria transmission in the United States. Since then, malaria case surveillance has been maintained to detect locally acquired cases that could indicate the reintroduction of transmission and to monitor patterns of antimalarial drug resistance experienced by U.S. travelers.

Through 1999, the majority of cases of malaria diagnosed in the United States have been imported from regions of the world where malaria transmission is known to occur, although congenital infections and infections resulting from exposure to blood or blood products are reported in the United States also. In addition, a limited number of cases are reported that might have been acquired through local mosquitoborne transmission (*4*).

State and local health departments and CDC investigate malaria cases acquired in the United States, and CDC analyzes imported cases to detect trends in acquisition. This information has been used to guide malaria prevention recommendations for travelers abroad. For example, an increase in *P. falciparum* malaria among U.S. travelers to Africa, an area with increasing chloroquine resistance, prompted CDC to change the recommended chemoprophylaxis regimen from chloroquine to mefloquine in 1990 (*5*).

The signs and symptoms of malaria illness are varied, but the majority of patients experience fever. Other common symptoms include headache, back pain, chills, increased sweating, myalgia, nausea, vomiting, diarrhea, and cough. A diagnosis of malaria should be considered for persons who experience these symptoms and who have traveled to an area with known malaria transmission. Malaria should also be considered in the differential diagnoses of persons who experience fevers of unknown origin, regardless of their travel history. Untreated *P. falciparum* infections can rapidly progress to coma, renal failure, pulmonary edema, and death. Asymptomatic parasitemia can occur among persons who have been long-term residents of malarious areas. This report summarizes malaria cases reported to CDC with onset of symptoms in 1999.

Methods

Data Sources

Malaria case data are reported to the National Malaria Surveillance System (NMSS) and the National Notifiable Diseases Surveillance System (NNDSS) (*6*). Although both systems rely on passive reporting, the numbers of reported cases might differ because of differences in collection and transmission of data. A major difference in the data collected in these two systems is that NMSS receives more detailed clinical and epidemiologic data regarding each case (e.g., information concerning the area to which the infected person has traveled). This report presents only data regarding cases reported to NMSS.

Cases of blood-film–confirmed malaria among civilians and military personnel are identified by health-care providers or laboratories. Each slide-confirmed case is reported to local or state health departments and to CDC on a uniform case report form that contains clinical, laboratory, and epidemiologic information. CDC staff review all report forms when received and request additional information, if necessary (e.g., when no recent travel to a malarious country is reported). Reports of other cases are telephoned directly by health-care providers to CDC, usually when assistance with diagnosis or treatment is requested. All cases that have been acquired in the United States are investigated, including all induced and congenital cases and possible introduced or cryptic cases. Information derived from uniform case report forms is entered into a database and analyzed annually.

Definitions

The following definitions are used in this report:

- **Laboratory criteria for diagnosis:** Demonstration of malaria parasites in blood films.
- **Confirmed case:** Symptomatic or asymptomatic infection that occurs in a person in the United States who has microscopically confirmed malaria parasitemia, regardless of whether the person had previous attacks of malaria while in other countries. A subsequent attack of malaria occurring in a person is counted as an additional case if the demonstrated *Plasmodium* sp. differs from the initially identified species. A subsequent attack of malaria occurring in a person while in the United States could indicate a relapsing infection or treatment failure result-

ing from drug resistance if the demonstrated *Plasmodium* sp. is the same species identified previously.

This report also uses terminology derived from the recommendations of the World Health Organization (*7*). Definitions of the following terms are included for reference.

- **Autochthonous malaria:**
  Indigenous. Mosquitoborne transmission of malaria in a geographic area where malaria occurs regularly.
  Introduced. Mosquitoborne transmission of malaria from an imported case in an area where malaria does not occur regularly.
- **Imported malaria:** Malaria acquired outside a specific area. In this report, imported cases are those acquired outside the United States and its territories (Puerto Rico, Guam, and the U.S. Virgin Islands).
- **Induced malaria:** Malaria acquired through artificial means (e.g., blood transfusion or using shared common syringes).
- **Relapsing malaria:** Renewed manifestations (i.e., clinical symptoms or parasitemia) of malarial infection that is separated from previous manifestations of the same infection by an interval greater than the usual periodicity of the paroxysms.
- **Cryptic malaria:** An isolated malaria case that cannot be linked epidemiologically to secondary cases.

Microscopic Diagnosis of Malaria

The early diagnosis of malaria requires that physicians consider malaria in the differential diagnosis of every patient who is experiencing fever; the evaluation of such a patient should include taking a comprehensive travel history. If malaria is suspected, a Giemsa-stained film of the patient's peripheral blood should be examined for parasites. Thick and thin blood films must be prepared properly because diagnostic accuracy depends on blood-film quality and experienced laboratory personnel* (see Appendix for procedures for accurately diagnosing malaria).

Results

General Surveillance

During 1999, CDC received 1,540 malaria case reports occurring among persons in the United States and its territories, representing a 25.5% increase from the 1,227 cases reported for 1998 (*8*). This incidence is the second highest number of reported cases since 1980 and represents the highest number of U.S. civilian cases reported in the past 30 years (Table 1). In 1999, a total of 833 cases occurred among U.S. civilians, compared with 636 cases reported for 1998, whereas the number of cases among foreign civilians also increased from 361 cases to 381 (Figure 1). In 1999, cases among U.S. military personnel also increased from 22 to 55. In 271 cases, information was insufficient to determine civilian or military status.

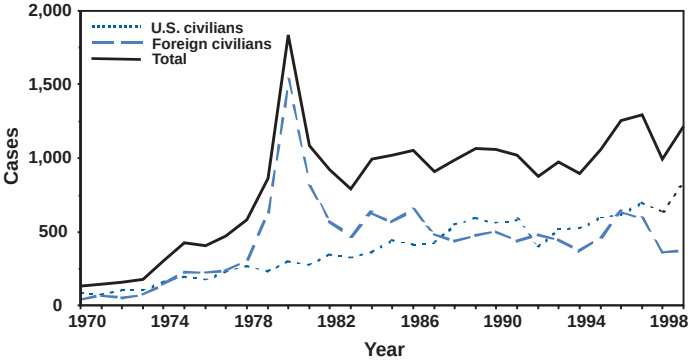
TABLE 1. Number of malaria cases* among U.S. and foreign civilians and U.S. military personnel — United States, 1970–1999

Year	U.S. military personnel	U.S. civilians	Foreign civilians	Status not recorded	Total
1970	4,096	90	44	17	**4,247**
1971	2,975	79	69	57	**3,180**
1972	454	106	54	0	**614**
1973	41	103	78	0	**222**
1974	21	158	144	0	**323**
1975	17	199	232	0	**448**
1976	5	178	227	5	**415**
1977	11	233	237	0	**481**
1978	31	270	315	0	**616**
1979	11	229	634	3	**877**
1980	26	303	1,534	1	**1,864**
1981	21	273	809	0	**1,103**
1982	8	348	574	0	**930**
1983	10	325	468	0	**803**
1984	24	360	632	0	**1,016**
1985	31	446	568	0	**1,045**
1986	35	410	646	0	**1,091**
1987	23	421	488	0	**932**
1988	33	550	440	0	**1,023**
1989	35	591	476	0	**1,102**
1990	36	558	504	0	**1,098**
1991	22	585	439	0	**1,046**
1992	29	394	481	6	**910**
1993	278	519	453	25	**1,275**
1994	38	524	370	82	**1,014**
1995	12	599	461	95	**1,167**
1996	32	618	636	106	**1,392**
1997	28	698	592	226	**1,544**
1998	22	636	361	208	**1,227**
1999	55	833	381	271	**1,540**

* A case was defined as symptomatic or asymptomatic illness that occurs in the United States in a person who has microscopy-confirmed malaria parasitemia, regardless of whether the person had previous attacks of malaria while in other countries. A subsequent attack of malaria occurring in a person is counted as an additional case if the demonstrated *Plasmodium* species differs from the initially identified species. A subsequent attack of malaria occurring in a person while in the United States could indicate a relapsing infection or treatment failure resulting from drug resistance if the demonstrated *Plasmodium* species is the same species identified previously.

* To obtain confirmation diagnosis of blood films from questionable cases and to obtain appropriate treatment recommendations, contact either your state or local health department or CDC's National Center for Infectious Diseases, Division of Parasitic Diseases, Malaria Epidemiology Branch at 770-488-7788.

FIGURE 1. Number of malaria cases among U.S. and foreign civilians — United States,* 1970–1999†



* Includes Puerto Rico, Guam, and the U.S. Virgin Islands.
† The substantial increase in the number of cases reported for 1980 primarily reflects cases diagnosed among immigrants from Southeast Asia.

Plasmodium Species

The infecting species of *Plasmodium* was identified in 1,317 (85.5%) of the cases reported in 1999. *P. falciparum* and *P. vivax* were identified in blood films from 46.0% and 30.7% of infected persons, respectively (Table 2). The 708 *P. falciparum* cases reported for 1999 represented a 34.9% increase from the 525 cases in 1998, whereas the number of *P. vivax* infections increased by 1.7% (from 464 in 1998 to 472 in 1999). Among 1,261 cases in which both the region of acquisition and the infecting species were known, 78.5% of infections acquired in Africa were attributed to *P. falciparum*; 9.3% were attributed to *P. vivax*. The converse was true of infections acquired in the Americas and Asia: 74.9% and 78.2% were attributed to *P. vivax*, and only 17.3% and 12.5% were attributed to *P. falciparum*, respectively.

Region of Acquisition and Diagnosis

Approximately 99% (n = 1,537) of reported cases were imported. Of 1,447 imported cases in which the region of acquisition was known, the majority, 62.3% (n = 901), were acquired in Africa; 18.7% (n = 271) and 17.0% (n = 246) were acquired in the Americas and Asia, respectively (Table 3).

TABLE 2. Number of malaria cases, by *Plasmodium* species — United States, 1998 and 1999

Plasmodium	1998		1999	
Species	No.	(%)	No.	(%)
P. falciparum	525	(42.8)	708	(46.0)
P. vivax	464	(37.8)	472	(30.7)
P. malariae	43	(3.5)	70	(4.6)
P. ovale	26	(2.1)	55	(3.6)
Mixed	7	(0.6)	12	(0.8)
Undetermined	162	(13.2)	223	(14.5)
Total	**1,227**	**(100.0)**	**1,540**	**(100.0)**

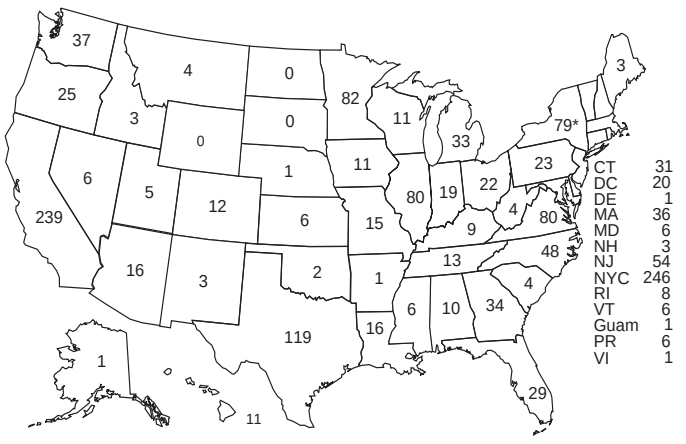
The highest concentration of cases acquired in Africa came from countries in western Africa (68.6%; n = 618), whereas the majority of cases acquired in Asia came from the Indian subcontinent (69.1%; n = 170). The other regions where imported cases of malaria were acquired were Central America and the Caribbean (13.8%; n = 200), South America (2.9%; n = 42) and Oceania (1.9%; n = 28). Information regarding region of acquisition was missing for 90 (5.9%) of the imported cases. The number of reported malaria cases acquired in Africa increased 27.6% (n = 901), compared with 1998, and a 19.7% (n = 271) increase in the Americas occurred, compared with 1998. Cases from Asia increased by a lesser margin (2.9%; n = 246), compared with 1998.

In the United States, the six health departments reporting the highest number of malaria cases were New York City (n = 246), California (n = 239), Texas (n = 119), Minnesota (n = 82), Virginia (n = 80), and Illinois (n = 80) (Figure 2). Of these, only Minnesota reported a decrease in cases in 1999, compared with 1998. This overall increase in reported number of cases might be a result of efforts to increase reporting from states or reflect an increased rate of international travel, a greater risk for malaria among travelers, improved access to health care, or more sensitive surveillance by state and local health departments.

Interval Between Arrival and Illness

The interval between date of arrival in the United States and onset of illness and the infecting *Plasmodium* species were known for 650 (42.3%) of the imported cases of malaria (Table 4). Symptoms began after arrival in the United States for 590 (90.8%) of these patients. Clinical malaria developed within 1 month after arrival in 370 (83.1%) of the 445 *P. falciparum* cases and in 65 (41.7%) of the 156 *P. vivax* cases (Table 4).

FIGURE 2. Number of malaria cases, by state in which the disease was diagnosed — United States, 1999



*Excludes New York City.

TABLE 3. Imported malaria cases, by country of acquisition and *Plasmodium* species — United States, 1999

Country of acquisition	*Plasmodium* species						
	P. falciparum	*P. vivax*	*P. malariae*	*P. ovale*	Unknown	Mixed	Total
Africa	**608**	**72**	**47**	**43**	**126**	**5**	**901**
Angola	0	1	1	0	2	0	**4**
Benin	5	1	0	0	0	0	**6**
Burkina Faso	3	0	0	0	0	0	**3**
Burundi	0	1	0	0	0	0	**1**
Cameroon	20	0	0	3	2	0	**25**
Central African Republic	3	0	0	2	0	0	**5**
Congo	5	1	0	1	2	0	**9**
Cote D'Ivoire	41	5	3	1	4	0	**54**
Democratic Republic of the Congo (Zaire)	2	0	0	1	1	0	**4**
Egypt	0	1	0	0	0	0	**1**
Equatorial Guinea	1	0	0	0	0	0	**1**
Ethiopia	2	15	0	1	3	0	21
Gabon	1	0	0	0	0	0	**1**
Gambia	10	0	0	2	2	0	**14**
Ghana	108	2	8	6	24	0	**148**
Guinea	9	0	2	0	1	0	**12**
Guinea-Bissau	1	0	0	0	0	0	**1**
Kenya	20	7	4	1	2	0	**34**
Liberia	25	3	8	2	23	4	**65**
Madagascar	1	3	1	0	3	0	**8**
Malawi	5	1	0	0	1	0	**7**
Mali	9	0	0	0	1	0	**10**
Mauritania	1	0	0	0	0	0	**1**
Mozambique	4	3	0	0	0	0	**7**
Namibia	3	1	0	1	0	0	**5**
Niger	2	0	0	0	2	0	**4**
Nigeria	183	5	10	10	22	0	**230**
Rwanda	2	0	0	1	0	0	**3**
Senegal	25	1	0	0	1	0	**27**
Sierra Leone	5	0	3	0	1	1	**10**
Somali Republic	0	2	0	0	2	0	**4**
South Africa	10	1	0	0	0	0	**11**
Sudan	10	2	0	1	2	0	**15**
Tanzania	12	2	1	3	2	0	**20**
Togo	11	1	0	0	1	0	**13**
Uganda	11	3	1	2	4	0	**21**
Zambia	4	2	0	0	0	0	**6**
Zimbabwe	6	0	1	0	3	0	**10**
Western Africa, unspecified	11	3	1	2	3	0	**20**
Central Africa, unspecified	1	0	0	0	0	0	**1**
Africa, unspecified	36	5	3	3	12	0	**59**
Asia	**27**	**169**	**11**	**6**	**30**	**3**	**246**
Afghanistan	0	1	0	0	0	0	**1**
Bangladesh	0	1	0	0	0	0	**1**
Burma	2	4	0	0	0	0	**6**
Cambodia	1	2	0	0	0	1	**4**
India	13	108	9	3	21	2	**156**
Indonesia	2	15	0	1	2	0	**20**
Korea (South)	0	18	0	0	1	0	**19**
Laos	2	3	0	0	1	0	**6**
Malaysia	0	0	0	1	0	0	**1**
Pakistan	0	5	1	0	3	0	**9**
Philippines	2	1	0	0	1	0	**4**
Sri Lanka	1	2	0	0	0	0	**3**
Syria	0	1	0	0	0	0	**1**
Thailand	2	2	0	0	1	0	**5**
Viet Nam	1	1	1	1	0	0	**4**
Yemen	1	3	0	0	0	0	**4**
Southeast Asia, unspecified	0	1	0	0	0	0	**1**
Asia, unspecified	0	1	0	0	0	0	**1**

TABLE 3. (*Continued*) Imported malaria cases, by country of acquisition and *Plasmodium* species — United States, 1999

Country of acquisition	*Plasmodium* species						
	P. falciparum	*P. vivax*	*P. malariae*	*P. ovale*	Unknown	Mixed	Total
Central America and the Caribbean	**30**	**138**	**5**	**1**	**24**	**2**	**200**
Belize	0	3	0	0	0	0	**3**
Dominican Republic	1	0	0	0	0	0	**1**
El Salvador	0	15	0	0	2	1	**18**
Guatemala	2	24	1	1	0	1	**29**
Haiti	19	1	0	0	7	0	**27**
Honduras	6	78	4	0	11	0	**99**
Nicaragua	2	16	0	0	3	0	**21**
Central America, unspecified	0	1	0	0	1	0	**2**
North America	**2**	**19**	**2**	**3**	**2**	**1**	**29**
Mexico	2	19	2	3	2	1	**29**
South America	**10**	**25**	**4**	**1**	**2**	**0**	**42**
Bolivia	0	1	0	0	0	0	**1**
Brazil	0	6	2	0	0	0	**8**
Ecuador	5	9	1	0	2	0	**17**
French Guyana	1	0	0	0	0	0	**1**
Guyana	3	0	1	0	0	0	**4**
Peru	1	4	0	0	0	0	**5**
Venezuela	0	4	0	0	0	0	**4**
South America, unspecified	0	1	0	1	0	0	**2**
Oceania	**2**	**24**	**0**	**0**	**2**	**0**	**28**
Papua New Guinea	2	21	0	0	2	0	**25**
Solomon Islands	0	2	0	0	0	0	**2**
Vanuatu	0	1	0	0	0	0	**1**
Europe/Newly Independent States	**0**	**1**	**0**	**0**	**0**	**0**	**1**
Armenia	0	1	0	0	0	0	**1**
Unknown	**29**	**21**	**1**	**1**	**37**	**1**	**90**
Total	**708**	**469**	**70**	**55**	**223**	**12**	**1,537**

TABLE 4. Number of imported malaria cases, by interval between date of arrival in the United States and onset of illness and *Plasmodium* species* — United States, 1999

Interval (days)	*P. falciparum*		*P. vivax*		*P. malariae*		*P. ovale*		Mixed		Total	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
<0†	40	(9.0)	17	(10.9)	2	(7.4)	1	(5.6)	0	(0)	60	(9.2)
0–29	370	(83.1)	65	(41.7)	21	(77.8)	7	(38.9)	2	(50.0)	465	(71.5)
30–89	28	(6.3)	32	(20.5)	3	(11.1)	4	(22.2)	1	(25.0)	68	(10.5)
90–179	4	(0.9)	25	(16.0)	1	(3.7)	2	(11.1)	1	(25.0)	33	(5.1)
180–364	1	(0.2)	14	(9.0)	0	(0)	2	(11.1)	0	(0)	17	(2.6)
≥365	2	(0.4)	3	(1.9)	0	(0)	2	(11.1)	0	(0)	7	(1.1)
Total	**445**	**(100.0)**	**156**	**(100.0)**	**27**	**(100.0)**	**18**	**(100.0)**	**4**	**(100.0)**	**650**	**(100.0)**

* Persons for whom *Plasmodium* species, date of arrival in the United States, or date of onset of illness is unknown are not included.
† Persons in these cases had onset of illness before arriving in the United States.

Only 7 (1.2%) of the 590 persons became ill >1 year after return to the United States. An additional 60 (9.2%) persons reported becoming ill before arriving in the United States.

Imported Malaria Cases

Imported Malaria Among U.S. Military Personnel

In 1999, a total of 55 cases of imported malaria were reported among U.S. military personnel. Of the 51 cases for whom information regarding chemoprophylaxis use was available, 14 patients were not using any prophylaxis.

Imported Malaria Among Civilians

A total of 1,212 imported malaria cases were reported among civilians. Of these, 831 (68.6%) cases occurred among U.S. residents, and 381 (31.4%) cases occurred among residents of other countries (Table 5). Of the 831 imported malaria cases among U.S. civilians, 550 (66.2%) had been acquired in Africa, an increase of 39.6% from cases reported in 1998. Asia accounted for 118 (14.2%) cases of imported malaria among U.S. civilians, whereas travel to the Central American and Caribbean regions accounted for an additional 91 (10.6%) cases. Of the 381 imported cases among foreign civilians, the majority of cases were acquired in either Africa (n = 207; 54.3%) or Asia (n = 85; 22.3%).

TABLE 5. Number of imported malaria cases among U.S. and foreign civilians, by region of acquisition — United States, 1999*

Area or region	United States No.	United States (%)	Foreign No.	Foreign (%)	Total No.	Total (%)
Africa	550	(66.2)	207	(54.3)	**757**	**(62.5)**
Asia	118	(14.2)	85	(22.3)	**203**	**(16.7)**
Central America/the Caribbean	91	(11.0)	66	(17.3)	**157**	**(13.0)**
South America	30	(3.6)	5	(1.3)	**35**	**(2.9)**
North America	11	(1.3)	14	(3.7)	**25**	**(2.1)**
Oceania	23	(2.8)	1	(0.3)	**24**	**(2.0)**
Europe/Newly Independent States	0	(0)	1	(0.3)	**1**	**(0.1)**
Unknown†	8	(1.0)	2	(0.5)	**10**	**(0.8)**
Total	**831**	**(100.0)**	**381**	**(100.0)**	**1,212**	**(100.0)**

* Persons for whom U.S. or foreign status is not known are excluded.
† Region of acquisition is unknown.

Antimalarial Chemoprophylaxis Use

Chemoprophylaxis Use Among U.S. Civilians

Information concerning chemoprophylaxis use and travel area was known for 768 (92.4%) of the 831 U.S. civilians who had imported malaria. Of these 768 persons, 498 (64.8%) had not taken any chemoprophylaxis, and 77 (10.0%) had not taken a CDC-recommended drug for the area visited (*9*). Only 159 (20.7%) U.S. civilians had taken a CDC-recommended medication (*9*). Data for the specific drug taken were missing for the remaining 36 (4.7%) travelers. A total of 125 (78.6%) patients on CDC-recommended prophylaxis had taken mefloquine weekly; eight (5.0%) had taken doxycycline daily; and 14 (8.8%) who had traveled only in areas where chloroquine-resistant malaria has not been documented, had taken chloroquine weekly. Twelve patients (7.5%) had taken combinations of drugs that included ≥1 CDC-recommended drugs for the travel region. Of the 77 patients taking a nonrecommended drug, 59 (76.6%) reported taking chloroquine either alone or in combination with another ineffective drug during travel to an area where chloroquine resistance had been documented.

Malaria Infection After Recommended Prophylaxis Use

A total of 214 patients (i.e., 159 U.S. civilians, 34 persons in the U.S. military, 10 foreign civilians, and 11 persons whose information regarding their status was missing) experienced malaria after taking a recommended antimalarial drug for chemoprophylaxis. Information regarding infecting species was available for 190 (88.8%) patients taking a recommended antimalarial drug; the infecting species was undetermined for the remaining 24.

Cases of *P. vivax* or *P. ovale* After Recommended Prophylaxis Use. Of the 214 patients who experienced malaria after recommended chemoprophylaxis use, 103 cases (48.1%) were caused by *P. vivax* and 15 (7.0%) by *P. ovale*. Notes on the malaria case surveillance reports indicated that 26 (22.0%) of these 118 patients were noncompliant with antimalarial prophylaxis.

A total of 33 (28.0%) cases of *P. vivax* or *P. ovale* occurred >45 days after arrival in the United States. These cases were consistent with relapsing infections and, thus, do not indicate prophylaxis failures. Information was insufficient (because of missing data regarding symptom onset or return date) to assess whether 78 cases were relapsing infections. Seven cases, all caused by *P. vivax*, occurred ≤45 days after the patient returned to the United States. Of these patients, three were known to be noncompliant with their antimalarial chemoprophylaxis. Region of acquisition varied for the four patients who were not known to be noncompliant (two from Central America, one from South America, and one from Papua New Guinea). Blood samples were not available; therefore, serum drug levels were not measured for any of these patients. The probable explanations for these cases are either inappropriate dosing or noncompliance that was not reported. Evidence is lacking that would indicate any new area of chloroquine-resistant *P. vivax*.

Cases of *P. falciparum* and *P. malariae* After Recommended Prophylaxis Use. The remaining 96 cases of malaria reported among persons who had taken a recommended antimalarial drug for chemoprophylaxis include 65 cases of *P. falciparum*, 7 cases of *P. malariae*, and 24 cases in which the infecting species was unidentified.

A total of 59 of the 65 *P. falciparum* cases among those who reported taking a recommended antimalarial drug were acquired in Africa, two in the Caribbean, and one in Asia. In 30 (46.2%) of these 65 cases, noncompliance with antimalarials was reported. Of the remaining 35 cases of *P. falciparum* for which the patient either specifically reported compliance with the regimen (n = 4) or compliance was unknown (n = 31), the majority were acquired in Africa (n = 32): 21 in western Africa, seven in eastern Africa, one in central Africa, one in south-

ern Africa, and one in an unspecified African region. Three cases were acquired outside Africa: two in the Caribbean (Haiti) and one in Asia (Laos/Thailand). Serum drug levels were available for two of these 35 patients. In both cases, the patients took mefloquine for prophylaxis for travel to Africa, and serum drug levels were below the therapeutic threshold ≤1 month after return, indicating either noncompliance with the recommended regimen or malabsorption of the drug. The probable explanations for the cases without serum drug levels are either inappropriate dosing or noncompliance.

Five of the seven *P. malariae* cases among those who reported taking a recommended antimalarial drug were acquired in Africa. In four (57.1%) of these seven cases, noncompliance with antimalarials was reported. In three cases, it was unknown whether the patient complied with prophylaxis; two had traveled in the Americas, and one in Africa.

Purpose of Travel

Purpose of travel to malaria-endemic areas was reported for 666 (80.1%) of the 831 U.S. civilians with imported malaria (Table 6). Of the U.S. civilians with malaria, the largest percentage (39.1%) were persons who had visited friends or relatives in malarious areas; the second and third largest percentages, 10.7% and 9.2%, had traveled for tourism and to do missionary work, respectively.

Malaria During Pregnancy

A total of 37 cases of malaria were reported among pregnant women in 1999, representing 7.0% of cases among women. Fourteen (37.8%) were among U.S. civilians. Eleven of these 14 women (78.6%) had traveled to visit friends and relatives, of whom 92.9% traveled in Africa. Only two pregnant women (14.3%) reported taking prophylaxis, compared with 33.2% of nonpregnant women. Twelve women (85.7%) were hospitalized, compared with 56.3% of nonpregnant women.

TABLE 6. Number of imported malaria cases among U.S. civilians, by purpose of travel at the time of acquisition — United States, 1999

	Imported Cases	
Category	**No.**	**(%)**
Visiting friends/relatives	325	(39.1)
Tourism	89	(10.7)
Missionary or dependent	76	(9.2)
Business representative	58	(7.0)
Student/teacher	48	(5.8)
Peace Corps volunteer	17	(2.1)
Refugee/immigrant	5	(0.6)
Air crew/sailor	3	(0.4)
Other/mixed purpose	45	(5.4)
Unknown	165	(19.9)
Total	**831**	**(100.0)**

Malaria Acquired in the United States

Congenital Malaria

No cases of congenital malaria were reported in 1999.

Cryptic Malaria

Three cases of cryptic malaria were reported in 1999 (*10,11*) and are described in the following case reports:

- **Case 1.** On July 3, 1999, a woman aged 32 years was examined at an emergency department in Georgia with a 2-day history of fever, headache, nausea, and vomiting. Her physical examination was normal. She was sent home with a diagnosis of acute viral gastroenteritis and was treated with promethazine and acetaminophen. Her symptoms persisted and she returned to the emergency department on July 4, 1999. The only laboratory abnormality determined was a white blood cell count of 3,500/mm^3. She was sent home with instructions to continue her prescribed promethazine and acetaminophen. She returned to the emergency department a third time on July 8, 1999, with persistent fever and was subsequently hospitalized. Admission laboratory values were remarkable for white blood cell count of 2,100/mm^3, hematocrit of 31.5%, and platelet count of 58,000/mm^3. On the second day of her hospitalization, malaria parasites were noted on the differential slide. The hospital laboratorians were unable to determine the malaria species, and she was therefore treated with quinine and doxycycline. The slide was sent to the Georgia Public Health Laboratory and CDC, and a diagnosis of *P. vivax* malaria was made. The patient was discharged on July 11, 1999, with primaquine and doxycycline and remained aparasitemic during subsequent follow-up visits.

  The patient reported no history of international travel, blood transfusions, organ transplantation, needle sharing, or prior malaria infection. She reported spending the evenings in her home with the door open but with a screen door in place. The patient's partner had returned from a trip to Mexico 3 weeks before the time of her illness and was reported to be asymptomatic. He was not available for interview, and the patient was unaware of where in Mexico he had traveled. No other neighbors were known to have had similar symptoms.
- **Cases 2 and 3.** On August 18, 1999, a male aged 11 years residing in Suffolk County, New York, was examined by his physician. The patient had a 5-day history of fever, rigors, abdominal pain, arthralgias, and vomiting.

Intracellular parasites consistent with *P. vivax* were subsequently noted on a blood film examined as part of a complete blood count. The patient was admitted to a community hospital on August 21 with a temperature of 102°F (38.9°C), hepatosplenomegaly, and multiple healing maculopapular lesions. Initial laboratory examinations revealed leukopenia (white blood cell count: 2,800/mm^3), anemia (hemoglobin: 9.8 g/dl), and thrombocytopenia (platelet count: 21,000/mm^3). Serum electrolytes and chest radiograph were normal. Urinalysis demonstrated a slightly elevated urobilinogen. Examination of peripheral thick and thin blood films at the New York State Department of Health and CDC confirmed *P. vivax*. The patient was treated with chloroquine, quinine, clindamycin, and primaquine, and he was discharged from the hospital on August 25.

The patient's parents reported that he had never traveled to a malarious area nor had a history of a blood transfusion or organ transplantation. The patient had spent 1 week (August 1–7) at a summer camp located 20 miles from his hometown, where he had slept in a tent. After his return home on August 7, the patient traveled to and attended another camp in Massachusetts for 2 days.

On August 22, 1999, a second male aged 11 years residing in Suffolk County, New York, was examined by his private physician for a 12-day history of vomiting, diarrhea, fever, chills, and fatigue. On August 27, 1999, a complete blood count demonstrated malarial ring forms; he was admitted to a hospital the following day. Physical exam on admission revealed a temperature of 100°F (37.8°C), no splenomegaly, and multiple healing maculopapular lesions consistent with insect bites. Initial laboratory examinations revealed leukopenia (white blood cell count: 4,300/mm^3), severe anemia (hemoglobin: 8 g/dl), and thrombocytopenia (platelet count: 134,000/mm^3). Routine blood and urine cultures were negative. Serology was negative for babesiosis. Urinalysis and chest radiograph were normal. Examination at the New York State Department of Health and CDC of peripheral thick and thin blood films revealed intracellular parasites consistent with *P. vivax* (<1% parasitemia). The patient was treated with chloroquine and primaquine and was discharged from the hospital on August 29, 1999.

His parents reported he had never traveled to a malarious area nor had a history of a blood transfusion or organ transplantation. This patient had spent the same week at the same summer camp as the patient in Case 2; that camp is located 15 miles from this patient's hometown. During the week, this patient had slept in a tent and participated in multiple outdoor activities.

Induced Malaria

No cases of induced malaria were reported in 1999.

Deaths Attributed to Malaria

Five deaths attributable to malaria were reported in 1999 and are described in the following case reports:

- **Case 1.** On January 14, 1999, a male aged 27 years arrived at an outpatient facility in Louisiana complaining that he had had fever and chills for 1 week and dark urine for 2–3 days. Blood cultures and thick and thin films were obtained and sent to the laboratory; the patient returned home. He went to an emergency department on January 15 and was admitted with nausea and vomiting. Films prepared the previous day revealed *P. falciparum* (11% parasitemia). He had traveled to Ghana on October 1, 1998, and proceeded directly to an offshore oil rig, where he had worked until December 27, 1998. He then spent 3 unscheduled days in southern Nigeria and 2 in London. He returned to the United States on January 2, 1999. The patient had not taken malaria chemoprophylaxis. He was initially treated with intravenous quinidine and doxycycline. On January 16, a change in his mental status was noted. He was transferred to the intensive care unit, and subsequently became unresponsive. His temperature was 103.4°F (39.7°C); a computerized tomography scan indicated diffuse cerebral edema. Intravenous clindamycin, phenytoin, furosemide, and mannitol were added to his medications. Although his parasite density decreased during the subsequent days to 0.06% by January 19, his mental status did not improve. He experienced renal failure, acute respiratory distress syndrome, disseminated intravascular coagulopathy, thrombocytopenia, and anemia. He was declared brain dead after an electroencephalogram was performed on January 19, and was pronounced dead on January 20.
- **Case 2.** On January 27, 1999, a male aged 55 years was hospitalized in Michigan after returning from a trip to Yemen and Sudan. He had not taken antimalarial prophylaxis during his trip. An examination of the patient's peripheral blood film revealed *P. falciparum* (2%–3% parasitemia). He was admitted to the hospital and administered quinine and doxycycline therapy. On his third day of hospitalization, the patient was improving clinically, except that he began experiencing transient alterations in his mental status. On the following day, the patient experienced one episode of generalized tonic-clonic seizures and went into cardiopulmonary arrest. After a period of asystole, the patient was resuscitated and transferred to the intensive care unit and placed on mechanical ventilation in a comatose state; treatment was

changed to intravenous quinidine. A blood film was taken that revealed no parasites. During the following days, the patient experienced renal failure and ileus. He continued to experience fevers (maximum 105°F, 40.6°C) and was started on broad-spectrum antibiotics; an exchange transfusion was performed. No source for the fever could be determined. The patient died on February 3; no autopsy was obtained.

- **Case 3.** On March 8, 1999, a woman aged 29 years was admitted to a hospital in New York City. She had traveled to Rwanda in October 1997 on business. On March 6, while returning to the United States by airplane, she began experiencing high fever, chills, headache, myalgia, and vomiting. She received medical care in Nairobi, where malaria was diagnosed, and chloroquine was administered. At her stopover in Europe, she apparently received a laboratory-confirmed diagnosis of malaria, and was told to seek further treatment after returning to the United States. The patient reported that she was taking mefloquine as chemoprophylaxis. Upon admission, the patient was febrile (104.9°F, 40.5°C) and hypotensive (blood pressure: 90/52). Her hematocrit was 41.4%, and she experienced mild elevations of transaminases and total bilirubin, and slight hypocalcemia. Rare *P. falciparum* ring forms were discovered upon blood film examination. She was initially treated with oral quinine and doxycycline. On March 9, approximately 24 hours after admission, the patient became unresponsive, and subsequently suffered cardiac arrest. She was resuscitated and transferred to the coronary care unit, where therapy with intravenous quinidine and broad-spectrum antibiotics was begun. Because of concerns regarding her cardiac status, the quinidine was subsequently discontinued. The patient's condition continued to deteriorate, and she died on March 10.
- **Case 4.** On October 28, 1999, a woman aged 43 years was admitted to a hospital in Nevada with a 1-day history of headaches, intermittent fevers, chills, sweats, diffuse abdominal pain, and the acute onset of bilateral lower extremity bone pain and upper extremity myalgia and arthralgia. The patient had returned on October 20 from a 6-month trip to Guatemala. Whether the patient had taken chemoprophylaxis is unknown. Examination at the time of admission demonstrated mild left-upperquadrant abdominal tenderness. Laboratory evaluation revealed leukopenia and thrombocytopenia; a blood film demonstrated *P. falciparum* (30%–50% parasitemia). Other laboratory studies demonstrated proteinuria, hematuria, hemoglobinuria, and elevated transaminases. Administration of chloroquine, levofloxacin, and metronidazole was begun. On October 30, the patient suffered respiratory decompensation and hypotension, necessitating endotracheal intubation, mechanical ventilation, administration of cardiac pressors, and transfer to the intensive care unit. Chest radiograph indicated bilateral infiltrates. The patient's clinical status continued to deteriorate, leading to a cardiac arrest from which she could not be resuscitated. She died on November 11, 1999.
- **Case 5.** On December 4, 1999, a woman aged 82 years was examined by her primary care physician in Nevada. She had a history of 3 days of fatigue, but no fever. The patient had traveled to Kenya in May 1999 for missionary work. She reportedly had taken mefloquine for antimalarial chemoprophylaxis, but discontinued it 1 month before the end of her trip when her supply ran out. She returned home in late November. She returned to the same physician on December 6 with fever; a blood film was obtained and revealed *P. falciparum* infection (13% parasitemia). The patient was provided prescriptions for quinine and doxycycline and sent home. On December 7, she was admitted to a Nevada hospital with mental status changes; therapy with intravenous quinidine and doxycycline was begun. On December 10, she became cyanotic and suffered a respiratory arrest. She was resuscitated and transferred to the intensive care unit, where she was placed on mechanical ventilation. The patient died on December 11, 1999.

Discussion

A total of 1,540 cases of malaria were reported to CDC for 1999, representing a 25.5% increase from the 1,227 cases reported for 1998. This change primarily resulted from an increase in cases acquired in Africa and the Americas. Beginning in 2000, CDC began to routinely contact state health departments to ask for outstanding reports from the previous reporting year, or for a statement that reporting was complete. That system change might account for the increase in cases in 1999, compared with 1998, although other possibilities include improved reporting to state health departments, increased international travel, changing patterns of travel (e.g., immigration from malarious areas or adventure tourism), or a decreased use of effective antimalarial chemoprophylaxis.

One reason for conducting malaria surveillance is to monitor emergence of drug resistance and the consequent failure of chemoprophylaxis; however, >60% of imported malaria among U.S. civilians occurred among persons who were either not taking prophylaxis or taking nonrecommended prophylaxis for the region to which they were traveling. Of the 89 persons who reported taking appropriate prophylaxis and

for whom adequate information was available regarding species and onset of symptoms to indicate that the infection was a primary infection rather than a relapse, for 42 cases (i.e., 35 *P. falciparum*, four *P. vivax*, and three *P. malariae*), insufficient information was available to determine whether they represented problems with compliance while using proper antimalarial chemoprophylaxis, reporting errors, or emerging drug resistance. However, no conclusive evidence existed to indicate a single national or regional source of infection among this group of patients or the failure of a particular chemoprophylactic regimen. Health-care providers are encouraged to contact CDC rapidly if they suspect chemoprophylaxis failure, thus enabling measurement of serum drug levels of the antimalarial drug in question.

CDC has received an increased number of reports of U.S. civilians who fail to take chemoprophylaxis, take an inappropriate regimen, or are not optimally compliant with the prescribed regimen. Therefore, CDC revised the NMSS case report form in 2001 to facilitate collection of more thorough data regarding chemoprophylaxis. The current form solicits more detailed information regarding the prescribed regimen (including the use of atovaquone-proguanil [Malarone™; manufactured by GlaxoSmithKline], a drug approved in the United States in July 2000 for treatment and chemoprophylaxis of malaria), the degree of compliance with the regimen, and the reasons for noncompliance, if any. Data gathered from the responses to these questions will be useful in generating public health messages to improve use of antimalarial chemoprophyalxis, and therefore, decrease malaria-associated morbidity and mortality among U.S. civilians.

The importance of taking correct precautions and chemoprophylaxis is underscored by the five fatal cases of malaria that occurred in the United States in 1999. An earlier review of deaths attributed to malaria in the United States identified key risk factors for fatal malaria, including failure to take recommended antimalarial chemoprophylaxis, refusal of or delay in seeking medical care, and misdiagnosis (*12*).

The occurrence of 14 cases of malaria among pregnant U.S. civilians is cause for concern. Malaria during pregnancy among nonimmune women is more likely to result in severe disease or contribute to an adverse outcome than malaria in a nonpregnant woman, and might also adversely affect the fetus (*13,14*). Pregnant travelers should be counseled to avoid travel to malarious areas, if possible. If deferral of travel is impossible, pregnant women should be informed that the risks for malaria outweigh those associated with prophylaxis, and that safe chemoprophylaxis regimens are available. Specific guidance for pregnant travelers is available from CDC's website at http://www.cdc.gov/travel/mal_preg_pub.htm (accessed November 30, 2001).

Signs and symptoms of malaria are often vague, but fever is usually present. Other symptoms include headache, chills, increased sweating, back pain, myalgia, diarrhea, nausea, vomiting, and cough. Prompt diagnosis requires that malaria be

TABLE 7. Sources for malaria prophylaxis, diagnosis, and treatment recommendations

Type of information	Source	Availability	Telephone number, Internet address,* or electronic mail address
Prophylaxis	CDC's voice information system	24 hours/day	877-394-8747
Prophylaxis	CDC's malaria facsimile	24 hours/day	888-232-3299
Prophylaxis	CDC's traveler's health Internet site	24 hours/day	http://www.cdc.gov/travel
Prophylaxis	*Health Information for International Travel*	Order from Public Health Foundation Publication Sales P.O. Box 753 Waldorf, MD 20604	877-252-1200 or 301-645-7773 or http://www.phf.org
Prophylaxis	*Health Information for International Travel*	24 hours/day	http://www.cdc.gov/travel
Diagnosis	CDC's Division of Parasitic Diseases Diagnostic Internet site (DPDx)	24 hours/day	http://www.dpd.cdc.gov/dpdx
Diagnosis	CDC's Division of Parasitic Diseases diagnostic CD-ROM (DPDx)	Order by electronic mail from CDC Division of Parasitic Diseases	dpdx@cdc.gov
Treatment†	CDC's Malaria Epidemiology Branch	8:00 am–4:30 pm Eastern Time, Monday–Friday	770-488-7788†
Treatment (after routine business hours)†	CDC's Malaria Epidemiology Branch	4:30 pm–8:00 am Eastern Time, weekends and holidays	404-639-2888† (Ask operator to page person on call for Malaria Branch)

* Internet addresses were accessed on December 5, 2001.
† These telephone numbers are intended for use by health-care professionals only.

included in the differential diagnosis of illness in a febrile person with a history of travel to a malarious area. Clinicians should ask all febrile patients for a travel history, including when evaluating febrile illnesses in international visitors, immigrants, refugees, migrant laborers, and international travelers.

Treatment for malaria should be initiated immediately after the diagnosis has been confirmed by a positive blood film. Treatment should be determined on the basis of the infecting *Plasmodium* species, the probable geographic origin of the parasite, the parasite density, and the patient's clinical status (*15*). Although nonfalciparum malaria rarely causes complications, persons who experience diagnosed *P. falciparum* infection are at risk for developing severe, life-threatening complications.

Health-care workers should be familiar with prevention, recognition, and treatment of malaria and are encouraged to consult appropriate sources for malaria treatment recommendations or call CDC's National Center for Infectious Diseases, Division of Parasitic Diseases at 770-488-7788. Detailed recommendations for preventing malaria are available 24 hours a day from CDC by telephone at 877-394-8747 (voice information system) or 888-232-3299 (facsimile request line), or on the Internet at http://www.cdc.gov/travel/diseases.htm#malaria (accessed November 30, 2001). In addition, CDC biannually publishes recommendations in the Health Information for International Travel (*9*), which is available for purchase from the Public Health Foundation at 877-252-1200 or 301-645-7773; it is also available and updated more frequently on CDC's Internet site at http://www.cdc.gov/travel (accessed November 30, 2001).

CDC provides support for the diagnosis of malaria through DPDx, a program that enhances diagnosis of parasitic diseases in the United States and the world. It includes an Internet site (http://www.dpd.cdc.gov/dpdx [accessed November 30, 2001]) that contains information regarding laboratory diagnosis, geographic distribution, clinical features, treatment, and life cycles of >100 species of parasites. The DPDx Internet site is also a portal for diagnostic assistance through telediagnosis. Digital images captured from diagnostic specimens are submitted for diagnostic consultation through electronic mail. Because laboratories can transmit images to CDC and rapidly obtain answers to their inquiries, this system allows more efficient diagnosis of difficult cases and more rapid dissemination of information. Approximately 36 laboratories in 34 states have or are in the process of acquiring the hardware to perform telediagnosis.

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Appendix

Microscopic Procedures for Diagnosing Malaria

To establish the diagnosis of malaria, a blood film must be prepared from fresh blood obtained by pricking the patient's finger (Figures A-1 and A-2).* The thin film is fixed in methanol before staining; the thick film is stained unfixed. Certain hospitals have a Wright-Giemsa stain available, which is acceptable; however, Wright stain alone will not reliably indicate *Plasmodium* parasites. For best results, the film should be stained with a 3% Giemsa solution (pH of 7.2) for 30–45 minutes. In *P. falciparum* infections, the parasite density should be estimated by counting the percentage of red blood cells infected — not the number of parasites — under an oil immersion lens on a thin film.

Thick blood films are more sensitive in detecting malaria parasites because the blood is concentrated, allowing a greater volume of blood to be examined. However, thick films are more difficult to read, and thin films might be preferred by laboratories that have limited experience. Plasmodium parasites are always intracellular, and they demonstrate, if stained correctly, blue cytoplasm with a red chromatin dot. Common errors in reading malaria films are caused by platelets overlying a red blood cell, concern regarding missing a positive slide, and misreading artifacts as parasites. Persons suspected of having malaria, but whose blood films do not indicate the presence of parasites, should have blood films repeated approximately every 12–24 hours for 3 consecutive days. If films remain negative, then the diagnosis of malaria is unlikely.

For rapid diagnosis, the thick and thin films should be made on separate slides. The thin film should be air-dried, fixed with methyl alcohol, and immediately stained. If no parasites are visible on the thin film, the laboratorian should wait until the thick film is dry, then examine it for organisms that might not have been detected on the thin preparation.

* In Figures A-1 and A-2, the hands are illustrated ungloved to better indicate their placement during the procedures. However, wearing gloves while processing blood specimens is recommended to prevent transmission of bloodborne pathogens (*MMWR 1988;37:377–82, 387–8* and *MMWR 1987;36[No. S2]*).

FIGURE A-1. Blood collection for thin or thick blood films

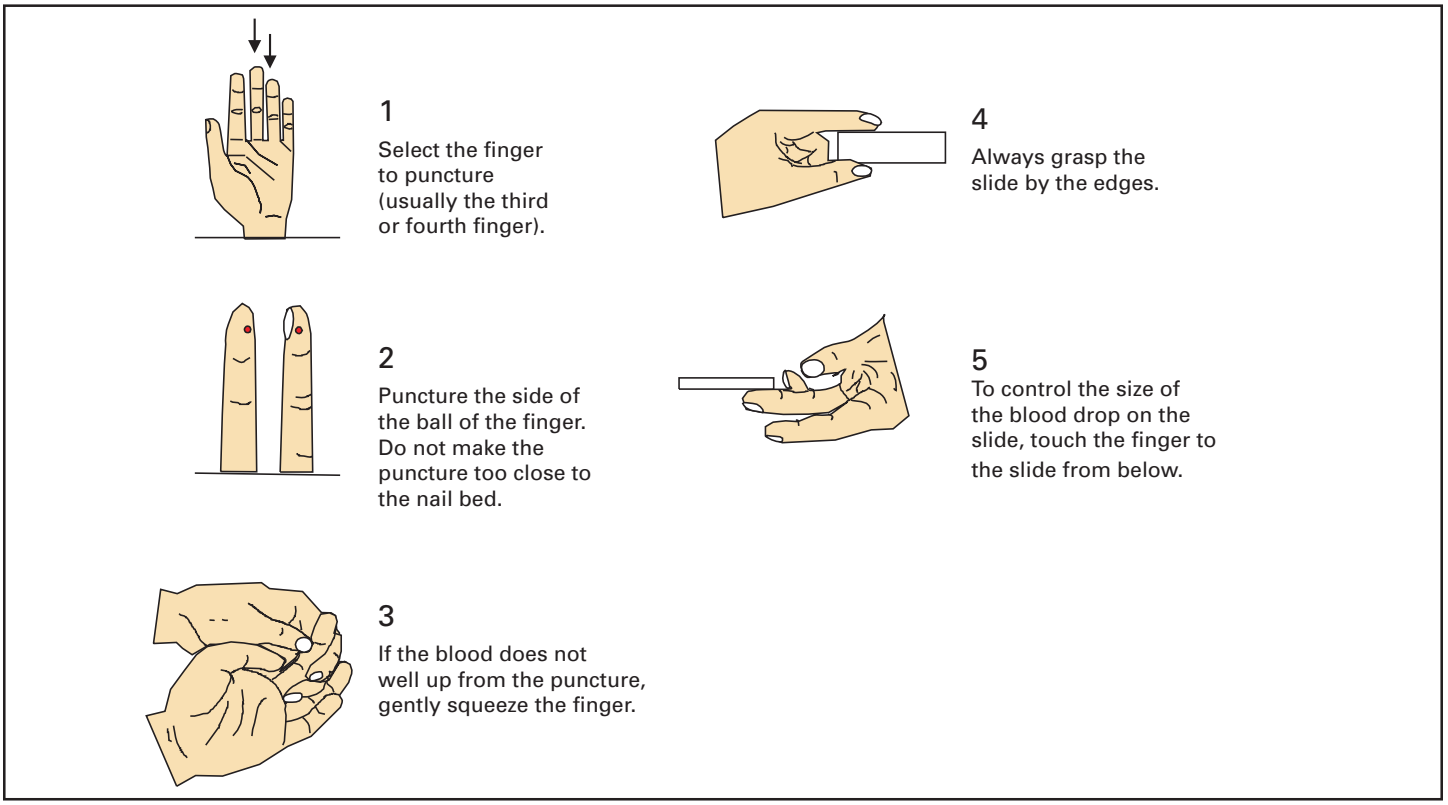
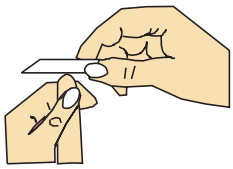
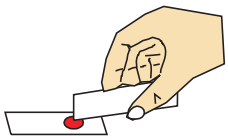


FIGURE A-2. Preparation of a thin and a thick blood film on the same slide



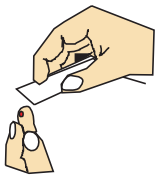
1

Touch the blood drop with a clean slide.



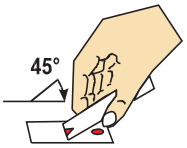
2

Using the corner of another slide, spread the blood drop into the shape of a circle or square of ~1cm^2.



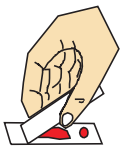
3

Gently squeeze the patient's finger again, and touch the edge of a clean slide to the newly formed blood drop.



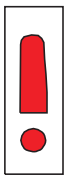
4

Take this slide and hold the edge that has the blood drop at an ~45° angle against the surface of the first slide. Wait until the blood completely spreads along the edge of the second slide.



5

While holding the second slide at the same angle, rapidly and smoothly push the slide forward.



6

Write the identification number on the slide. Wait until the thick film is completely dry before staining it.

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