Tuberculosis in San Diego County: A Border Community Perspective

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SYNOPSIS

Objectives. To describe the epidemiology of active disease caused by *Mycobacterium tuberculosis* in San Diego County from 1989 to 1993 and to identify the specific subgroups for whom the impact of the disease was most pronounced.
Method. The authors reviewed all 1860 reports of verified tuberculosis (TB) cases included in the surveillance database maintained by the San Diego County Health Department's TB Control Program. Data were analyzed by age, gender, ethnicity, nativity, HIV co-infection, major site of infection, and drug resistance.
Results. Between 1989 and 1993, San Diego County witnessed a greater increase (77.7%) in the number of incident TB cases than the state of California as a whole (22.8%) or the United States (9.9%). The local resurgence of TB was reflected in increasing case counts among specific subpopulations—immigrants from countries with high endemic rates of TB (62.5% of the new cases), U.S.-born members of minority groups, the elderly, and young adult males.
Conclusions. Tuberculosis cases in San Diego County have increased each year since 1989, with certain population subgroups exhibiting more dramatic increases in case rates than those reported nationally. San Diego County is one of the principal entry points for the western United States and a popular travel destination. These factors have led to a dramatic increase in the incidence of TB in the county. A range of tailored surveillance, treatment, and control strategies—some of which have already been implemented—will be needed to control the spread of the disease.

Regional variations in tuberculosis (TB) morbidity have been reported in the United States, with higher rates in the western states than the rest of the country.[1] Of the Centers for Disease Control and Prevention's (CDC) 51 reporting areas across the country, California ranked first in 1993 in the number of new cases, accounting for 20% of the total national caseload.[2] Although California's case rate began to decline in 1993 and has continued to do so, the rates in the state's southernmost county, San Diego, increased during the five years examined. In 1993, CDC identified San Diego County as one of the 13 highest TB incidence areas in the United States. The county's age-adjusted TB incidence rate of 17.4 for 1993 was significantly higher than the national average of 9.7

(see Table 1) and five times the Public Health Service's Year 2000 national objective of 3.5.

The authors believe that the increase cannot be attributed to the expanded reporting form implemented in 1993. In this paper we describe the epidemiology of TB in San Diego County between 1989 and 1993—the latest years for which complete data are available for analysis. We examine the patterns of disease occurrence by age, gender, ethnicity, nativity, co-infection with HIV, major sites of infection, and drug susceptibilities. From this analysis, we identify high prevalence subpopulations toward whom prevention and control programs will need to be directed.

Methods

The authors reviewed all 1860 cases[3] that were reported by the San Diego County Tuberculosis Control Program from 1989 to 1993 and confirmed by the CDC. A case was confirmed either bacteriologically (a culture grew *Mycobacterium tuberculosis*) or clinically (the person was symptomatic or showed clinical improvement while on two or more anti-TB drugs, or both).[4]

Local case reports are forwarded to the state TB Control Branch to verify that the case has not been reported by another jurisdiction within one year of submission. The state office in turn forwards the verified case reports without the patient's name, telephone number, or address to the CDC for final confirmation.[3]

Surveillance information about cases is limited to questions contained in CDC form 72.9, Report of Verified Case of Tuberculosis. Expansion of the form in 1993 did not alter the variables analyzed in this study. Cases are self-classified on the form into race-ethnic categories specified by *Federal Statistical Policy Directive No. 15*.[5]

For this paper, data on American Indians-Alaskan Natives were omitted because of extremely small numbers and therefore unstable rate estimates. Data on HIV-infected TB cases were obtained from a separate and confidential database and matched with the TB surveillance dataset by last name, first name, date of birth, and gender.

U.S. denominator data were obtained from *Health, United States*;[6] California denominator data from the California Department of Finance's *Population Projections*, the P-1 Report;[7] and data for San Diego County from intercensal estimates prepared by Jerry Goodman, PhD, San Diego County Biostatistician. To facilitate comparison across groups that exhibited dissimilar age distributions, we age-adjusted incidence rates by the direct method using as the standard population the 1990 estimate of U.S. residents published by the National Center for Health Statistics.[6] All rates refer to cases per 100,000 population. We calculated case rates by age, gender, and ethnicity. Ninety-five percent confidence intervals were calculated using the Mantel-Haenszel robust variance estimate[8] to describe the excess morbidity of various racial-ethnic groups, using the group with the lowest rates, non-Hispanic whites, for comparison.

Table 1. Tuberculosis case counts, crude rates, age-adjusted rates,[a] five-year average annual case rates per 100,000,[b] and rate ratios: United States, California, and San Diego County,[c] 1989–1993

	U.S.[c]	California[c]	San Diego County[c,d]
1989			
Cases	23,495	4,212	264
Crude rate	9.5	14.5	10.9
Age-adjusted rate	9.5	14.8	11.1
1990			
Cases	25,710	4,889	329
Crude rate	10.3	16.3	13.2
Age-adjusted rate	10.3	16.7	13.5
1991			
Cases	26,286	5,273	366
Crude rate	10.4	17.2	14.7
Age-adjusted rate	10.4	17.5	14.9
1992			
Cases	26,673	5,382	432
Crude rate	10.5	17.2	16.6
Age-adjusted rate	10.4	17.5	16.7
1993			
Cases	25,813	5,173	469
Crude rate	9.8	16.2	17.0
Age-adjusted rate	9.7	16.5	17.4
Average annual rate			
Crude rate	10.1	16.3	14.6
Age-adjusted rate	10.1	16.6	15.3

[a]Age adustment was performed by the direct method using the 1990 U.S. population as the standard population: ages 0–4 (18,758,000), 5–14 (35,095,000), 15–24 (80,596,000), 45–64 (46,710,000).

[b]Source: reference 3.

[c]Denominator data for the United States were obtained from reference 6, for California from reference 7, and for San Diego County from the 1990 U.S. Census and from intercensal population estimates prepared by Dr. Jerry Goodman, San Diego County Biostatistician.

[d]Data for American Indians and Alaskan Natives are not included because of extremely low case counts and therefore unstable rate estimates.

Results

From 1989 to 1993, San Diego County experienced a 77.7% increase in the TB case count and a 56.8% increase in the age-adjusted case rate (Table 1). The county's five-year average annual age-adjusted case rate of 15.3 per 100,000 population is 51.5% higher than the national figure.

Table 2 shows the gender and age distribution of TB cases in San Diego county for the years 1989–1993. Rates for males exceeded those for females by approximately 40% to 90% throughout the study period. The percent increase in age-adjusted rates over time is also greater in males (65.2%) than in females (58.9%). Without exception, the male excess in TB case rates holds for every ethnic group examined.

Table 2. Gender and age distribution of tuberculosis cases and case rates per 100,000 by year, San Diego County, 1989–1993

	Gender (percent of all cases)						Age (percent of all cases)											
	Male (61.2)			Female (38.8)			<5 yrs (0.0)		5–14 yrs. (3.1)		15–24 yrs. (13.3)		25–44 yrs. (37.5)		45–64 yrs. (20.4)		>65 yrs. (18.5)	
	Cases	Crude Rate	Age-adjusted[a] Rate	Cases	Crude Rate	Age-adjusted[a] Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
1989	156	12.6	13.5	108	9.1	9.0	12	6.3[b]	6	1.9[b]	32	7.8	103	12.1	55	14.2	56	21.1
1990	205	16.1	17.1	124	10.1	10.0	20	10.3[b]	6	1.8[b]	40	9.4	127	14.5	71	17.8	65	23.8
1991	212	16.3	17.2	154	12.3	12.2	36	18.1[b]	13	3.9[b]	61	13.7	118	13.9	74	19.2	64	23.0
1992	283	21.3	22.0	149	11.7	11.6	27	13.3[b]	12	3.5[b]	60	13.6	185	20.2	82	19.8	66	23.2
1993	283	21.0	22.3	186	14.3	14.3	39	18.9[b]	20	5.8[b]	55	12.2	164	15.7	98	23.3	93	31.8
Average Annual	228[c]	17.6	18.5	144[c]	11.5	11.4	27[c]	13.5[b]	11[b]	3.4[b]	50[c]	11.2	133[c]	16.4	76[c]	19.8	69[c]	24.7

[a]Age adustment was performed by the direct method using the 1990 U.S. population as the standard population: ages 0–4 (18,758,000), 5–14 (35,095,000), 15–24 (80,596,000), 45–64 (46,710,000).

[b]Cases are too few to produce statistically reliable rate estimates.

[c]Numbers have been rounded.

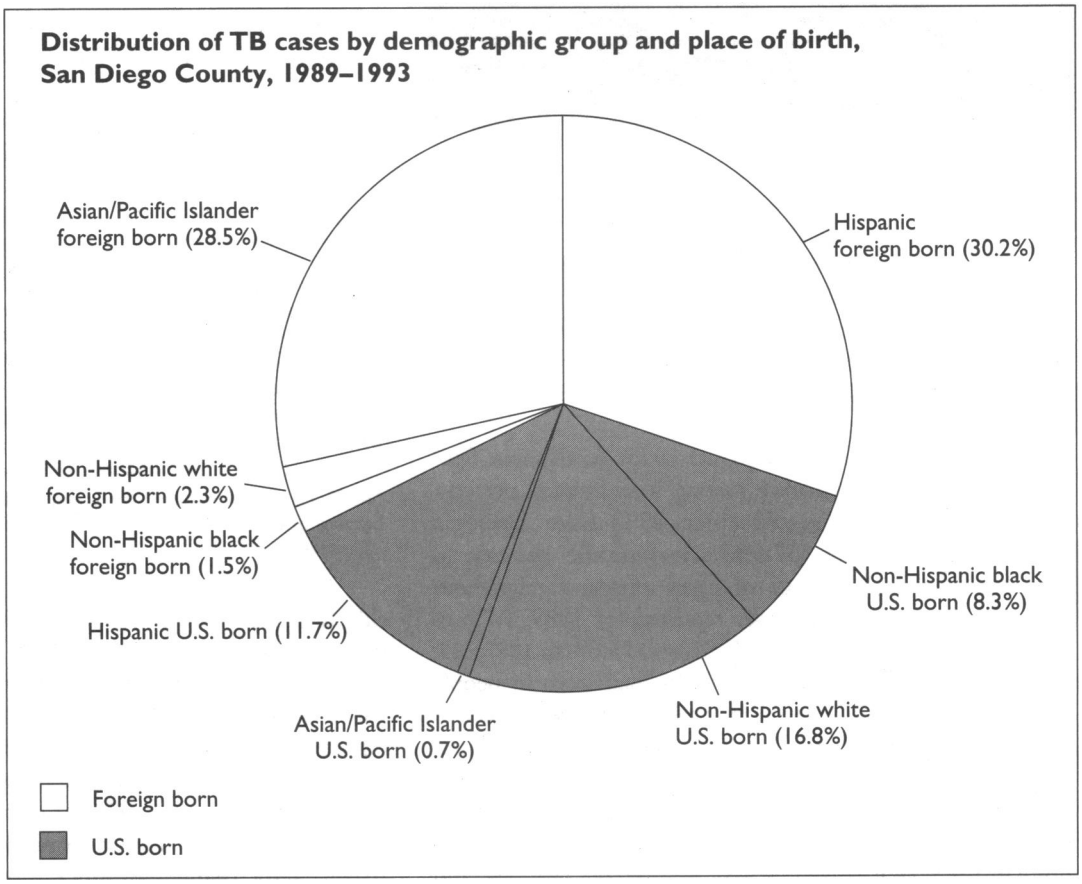
Among both males and females, Hispanics outnumbered the other ethnic groups.

The major sites of disease included the lungs (74.7%), the cervical lymph nodes (6.5%), and the lung pleura (5.9%).

People ages 25 to 44 contributed the largest *proportion* (37.5%) of cases, although those ages 65 and older consistently had the highest *rate*, followed by the 45–64 age group. Of all age groups, 5- to 14-year-olds showed the greatest increase over time in number of cases. Children younger than age 5 showed an increase in rates from 1989 to 1991 only to drop in 1992 and increase again in 1993. Pediatric cases (age at time of diagnosis 14 or younger), accounting for a little more than 10% of all cases, more than tripled in both the 0–4 and 5–14 age groups. Caution is warranted in the interpretation of these findings, however, because the numbers of cases are extremely small.

Among males, some 40.5% fell in the 25–44 age group, followed by those ages 45 to 64 (21.7%) and 65 and older (17.8%). Likewise, among females, women 25 to 44 had the highest percentage (32.7%), followed by the 65 and older (19.6%) and 45–64 (18.4%) age groups.

More than 60% of all cases were among immigrants,



94% of them either Hispanic or Asian/Pacific Islander. Overall, the Asian/Pacific Islander group exhibited the highest rates each year, averaging four and a half times higher than the rate for San Diego County. Hispanics consistently had the second highest rates. While non-Hispanic blacks exhibited a similar age-adjusted case rate in 1993 to that of Hispanics, because of a lower base rate in 1989 non-Hispanic blacks experienced the largest rate increase over time (78.7%) among all ethnic groups. Non-Hispanic whites consistently had the lowest TB case rates. Rate ratios comparing each of the other groups to non-Hispanic whites show substantial excess TB morbidity among ethnic minorities (Table 1). Each of these comparisons is statistically significant ($P < 0.001$).

Of the Asian/Pacific Islander group, 97% of those with TB were foreign born. (See Figure.) Of these, 55.5% originated from the Philippines, 24.9% from Vietnam, 5.4% from Laos, and 3.6% from Cambodia. One-third of the foreign-born Asian/Pacific Islander people with TB were ages 25 to 44, one-quarter were ages 45 to 64, and another quarter were ages 65 and older.

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The foreign-born comprised 71.8% of Hispanic cases, with 93.1% from Mexico. Similar to the foreign-born Asian/Pacific Islander group, the majority (33.9%) were ages 25–44 and male (60.9%).

Non-Hispanic blacks comprised 10.1% of all cases. Seventeen percent of them were among foreign-born persons, most of whom immigrated since 1992 from Ethiopia (37.5%) and Somalia (37.5%). A dramatic increase is observed in the percentage of cases among foreign-born Non-Hispanic blacks (no cases reported for 1989, 7.7% in 1990, 11.8% in 1991, 24.6% in 1992, and 25.0% in 1993). Of all cases among Non-Hispanic blacks, half were in people ages 25–44, and slightly more than two-thirds were male.

Non-Hispanic whites accounted for 18.4% of all cases. Of these 342 cases, 12.3% were among foreign born and 72.8% were among males. Ninety-four percent were among those ages 25 and older, with approximately equal proportions in the young adult (25–44), middle-age (45–64), and elderly groups. This population exhibited the lowest percent increase in case rates (Table 1).

People co-infected with HIV more than doubled from 25 in 1989 to 54 in 1993. Among the 199 AIDS-TB cases reported in the study interval, 188 of 199 were male and 150 of 199 were ages 25–44. Non-Hispanic whites comprised the largest proportion (42.2%) of co-infected, followed by Hispanics (36.7%), non-Hispanic blacks (17.1%), and the Asian/Pacific Islander group (4.0%).

Table 3. Tuberculosis case counts, crude rates, age-adjusted rates,[a] five-year average annual case rates per 100,000,[b] and rate ratios[c] by demographic group: San Diego County, 1989–1993

	Non-Hispanic White	Non-Hispanic Black	Hispanic	Asian/Pacific Islander
1989				
Cases	55	22	99	85
Crude rate	3.5	15.3	19.9	47.7
Age-adjusted rate	3.3	20.2	25.9	57.9
1990				
Cases	69	26	133	97
Crude rate	4.2	17.6	26.0	52.9
Age-adjusted rate	4.0	23.6	31.2	63.4
1991				
Cases	69	34	165	98
Crude rate	4.1	20.9	36.2	52.4
Age-adjusted rate	4.0	27.3	42.2	65.9
1992				
Cases	70	57	184	117
Crude rate	4.1	37.1	34.6	61.2
Age-adjusted rate	3.9	41.6	41.1	72.2
1993				
Cases	79	48	203	139
Crude rate	4.6	30.7	30.8	71.5
Age-adjusted rate	4.4	36.1	36.2	92.4
Average annual rate				
Crude rate	4.1	23.0	34.4	57.3
Age-adjusted rate	3.9	29.5	43.2	70.6
Rate ratio[c]				
Crude rate	1.0	5.6	8.4	14.0
(95% C.I.)[d]		(3.8,8.4)	(6.3,11.2)	(10.3,19.0)
Age-adjusted rate	1.0	7.6	11.1	18.2
(95% C.I.)[d]		(7.4,7.7)	(10.9,11.3)	(17.8,18.5)

[a]Age adustment was performed by the direct method using the 1990 U.S. population as the standard population: ages 0–4 (18,758,000), 5–14 (35,095,000), 15–24 (80,596,000), 45–64 (46,710,000).

[b]Source: reference 3.

[c]Rate ratio = age-adjusted rate for a population/age-adjusted rate for white population.

[d]Calculated using the Mantel-Haenszel robust variance estimate.

NOTE: Data for American Indians and Alaskan Natives are not included because of extremely low case counts and therefore unstable rate estimates.

Drug-resistant TB is of rising concern nationally. Although the percentage of San Diego County cases with known drug susceptibilities (n = 1516) that were resistant to more than one first-line primary anti-TB drug[9] (isoniazid, rifampin, ethambutol, streptomycin) has remained fairly stable at approximately 20% over the five-year study period, the actual number of resistant cases has almost doubled. The pattern for multidrug-resistant TB[10] has been similar. On average, multidrug-resistant TB comprised 2% of tested isolates over the five years.

Discussion

San Diego County is the second most populated county in California and includes the sixth largest metropolitan area in the United States. A rapid influx of immigrants keeps the population fluid and ethnically diverse. As of 1993, an estimated 65% of the county's nearly three million residents were classified as non-Hispanic white, 20% as Hispanic, 7% as Asian/Pacific Islander, and 6% as non-Hispanic black. Against this demographic profile, persons self-identified as Hispanic constituted 42.2% of all verified TB cases; as Asian/Pacific Islander, 28.8%; as non-Hispanic black, 10.1%; and as non-Hispanic white, 18.4%.

Language, economic, and cultural differences must be taken into account for a TB control program to be effective.

With 81.1% of all cases occurring among 33% of the population, language, economic, and cultural differences must be taken into account for a TB control program to be effective. After adjusting for differences in the population size and structure, the Asian/Pacific Islander group has the highest TB case rate, followed by Hispanics, non-Hispanic blacks, and non-Hispanic whites. Age-adjusting the data allows a comparison of case rates, controlling for variation between each subpopulation's age distribution. Health care reform efforts focusing on equality in health care access and in quality of care will hopefully bring these hypothetical adjusted rates closer to the true crude rates. In the interim, however, focusing on the groups that exhibit the highest case counts may prove to be the most effective measures when prevention and control of TB are the goals.

It is difficult to assess with certainty whether the observed association of TB with age is attributable to cohort effects, reactivation of disease with age, an artifact of a reduced denominator as death takes its toll in an aging population, or these three factors combined. What is evident is that in every ethnic group both the numbers and the rates are higher in males than in females. Across ethnic groups, the highest percentage of cases is found among young adults in the 25 to 44 age range, probably due to work and living conditions and other factors that place them at greater risk of infection, activation, or reactivation (migrant work, incarceration, homelessness, HIV infection, drug and alcohol abuse). However, the highest case *rate* occurs among the elderly.

Among children, the increase in TB case counts and rates is of special concern since these cases represent newly acquired infections as well as indicators of untreated adult infection. It is difficult to evaluate the significance of this increase, however, because of the small numbers involved. From a public health practice standpoint, it is noteworthy that a Pediatric TB Task Force has been established in San Diego to develop and implement short- and long-term strategies to improve the monitoring of pediatric TB and to provide adequate TB-related medical care to children.

Non-Hispanic whites accounted for the greatest number of AIDS-TB cases. Co-infected Hispanics experienced the greatest percent increase in TB incidence and contributed the second highest number of dual diagnosed cases. The collection of AIDS-TB data was limited by confidentiality issues—as found by Mueller and coworkers[11]—resulting in a possible undercount of cases of co-infection.

Our findings lend support to Bloch's observations that TB "is primarily and increasingly a disease of minorities and the foreign-born."[12] In 1990, foreign-born persons made up only 20.7% of San Diego County's population,[13] yet they represented nearly two-thirds (62.5%) of the 1860 verified TB cases. The proportion is almost double that found nationally and higher than in other Southern states such as Texas and Florida.[1,2,12,14,15] Immigrants and refugees from Mexico, the Philippines, Vietnam, Laos, and Cambodia have contributed heavily to the local increase in case rates. The percentage increase observed among non-Hispanic blacks from 1989 to 1993 is predominantly due to a rise in the foreign-born non-Hispanic black population, primarily those who immigrated from Ethiopia and Somalia.

With an increasing proportion of new cases occurring among foreign-born persons, efforts within U.S. immigration procedures and those that bolster U.S. involvement in international TB programs will benefit international, national, state, and local TB control strategies.[14] People who desire to immigrate to the United States are required by the U.S. Immigration and Naturalization Service to have a medical examination in their country of origin prior to departure. Through this examination, people with TB (either active or latent infection) are classified according to their stage of TB disease and infectiousness.

Several problems exist with the current procedures, including: (*a*) delays of 2 to 4 weeks in the receipt of classified immigration documents by the appropriate TB control program, (*b*) difficulty tracking the movements of immigrants in the designated jurisdiction, (*c*) active infections that remained untreated or ineffectively treated at the time of immigration to the United States, and (*d*) noncompliance or noncompletion of appropriate treatment regimen by infected immigrants requiring treatment.

It has been reported nationally that only 12% of TB Class A Immigrants (that is, active TB, noncommunicable for travel purposes) had active disease, yet 1.2% of Class B Immigrants (TB, not considered active) had active TB.[1] In San Diego County, however, there is not a system in place to determine these rates effectively or to ensure that all TB-classified Immigrants are followed prospectively.

To deal with this situation, a pilot project for identifying, tracking, and treating TB in newly arrived immigrants has been implemented under the San Diego TB Control Program. In addition to medical interventions, based on the project findings, educational programs will be developed for the immigrants, their sponsors, and local health care providers.

There are more than 65 million crossings annually between San Diego County and the city of Tijuana, Mexico. The two-way traffic links the regions closely and makes the control of TB in San Diego increasingly challenging. In response to the immediate need to control TB among people who live in Mexico and work in San Diego County, the San Diego TB Control Program and the Tijuana Health Department have developed the Binational TB Control Program. This collaborative venture facilitates discussion and problem solving related to border region TB control and provides a mechanism to track cases that would otherwise be lost to follow-up.

Interpretation of our findings must take into consideration some additional issues. The surveillance data presented in this paper exclude cases among persons who do not consider San Diego their *permanent* residence. There is a concern that if these persons were to be counted, the actual TB case rate in the county would be higher than what is reported. Furthermore, because San Diego is a point of entry to the United States and often a temporary place of residence, the TB Control Program actually provides TB-related treatment to more people than are officially reported and consequently does not receive reimbursement for these unreportable cases.

In sum, San Diego County is faced not only with a readily visible TB problem but also with a dynamic TB population that is more difficult to quantify. The presence of unquantifiable numbers of undocumented persons also adds to the complexity of disease control and surveillance. This study highlights the magnitude of the challenge to control TB in one of the most populous counties of California. The findings underscore the need for the continuing implementation of aggressive TB surveillance, management, and preventive measures delivered through culturally sensitive strategies that would benefit both the ethnic and mainstream communities.

This paper was presented in part at the 123rd Annual Meeting of the American Public Health Association, San Diego CA, October 1995.

The authors thank Mary Heim, Demographic Research Unit, Department of Finance, State of California; Gloria Kelly, Division of TB Elimination, Centers for Disease Control and Prevention; Yin-Ming Kean, MPH; and John Celto for their technical assistance.

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