stresses contributing to the abuse and neglect of county children. While the Brown County partnership rests on an informal agreement between the agency administrators to encourage the collaboration discussed in this paper, in large urban counties bureaucracy may demand more formalized agreements for collaborative activity. Bureaucracy, however, should not deter professionals from collaboration.

The Brown County partnership can serve as a model for other social service and public health nursing service agencies. The shared expertise of these disciplines—characterized in the relationship between departments in Brown County—can meet the needs of vulnerable children and their families everywere.

References

Ziefert, M., and Faller, K. C.: The interdisciplinary team and the community. *In* Social work with abused and neglected children, edited by K.C. Faller. Free Press, New York, 1981, pp. 173–176.

2. National Center on Child Abuse and Neglect: Multidisciplinary teams in child abuse and neglect programs. U.S. Department of Health, Education, and Welfare, Washington, DC, 1978.
3. Church, G. M.: Understanding each other to achieve a common goal. Am J Nurs 56: 201–204 (1962).
4. King, E. S., and Fasso, T. E.: How nursing and social work dovetail. Am J Nurs 62: 89–90 (1962).
5. Jansen, P. W.: The social worker on the public health agency team. Nurs Outlook 16: 42–44 (1968).
6. Christensen, M. L., Schommer, B. L., and Velasquez, J.: An interdisciplinary approach to preventing child abuse. Am J Maternal-Child Nurs 9: 108–112 (1984).
7. Rosenberg, H. N.: Public health nurses and social workers: An exploration of professional functions and collaborative relationships. Doctoral dissertation, University of Pittsburgh, 1974.
8. Miller, E. L.: Interviewing the sexually abused child. Am J Maternal-Child Nurs 10: 103–105 (1985).

Hansen's Disease in Native-Born Citizens of the United States

BOBBY Z. JOSEPH, MB, BS
LEO J. YODER, MD
ROBERT R. JACOBSON, MD, PhD

All three authors are or were staff members at the National Hansen's Disease Center, Carville, LA 70721. Mr. Joseph was a trainee, Dr. Yoder is a Staff Physician, and Dr. Jacobson is Chief of the Clinical Branch.

Erat Joseph, PhD, Professor and Chairman, Department of Civil Engineering, Southern University, Baton Rouge, LA, assisted in the statistical evaluation of the data.

Tearsheet requests to Dr. Yoder.

Synopsis

This paper presents a statistical analysis of data on 1,309 Hansen's disease (HD) patients born in the continental United States during the 50 year period 1932–81. Fifty-six percent of them were born in Texas. The cases of 66 percent were classed as multibacillary, 31 percent were considered paucibacillary, and the type was unknown for 3 percent. Blacks and whites appeared to be equally susceptible to Hansen's disease. Thirty percent had a history of contact with Hansen's disease.

The age at diagnosis has increased an average of 2.7 years per decade, and the increase has accelerated in the last two decades. If the present trend continues, Hansen's disease among native-born citizens of the United States will ultimately disappear.

HANSEN'S DISEASE HAS BEEN KNOWN in the United States since 1758 when it was reported in Florida. It is thought to have been introduced into the Americas by early Spanish explorers and later by the slave trade from Africa and by other groups, such as the French in South Louisiana (*1*). These groups not only introduced the disease but also necessarily introduced a susceptible population, since Hansen's disease has never been reported in a full blooded American Indian (*2*). The disease was

first reported in south Louisiana in 1766, and in 1785 a hospital to treat patients with the disease was established in New Orleans by the Spanish Commissioner of Louisiana (*1*). The facility, now known as the National Hansen's Disease Center, was first opened in 1894 by the State of Louisiana at Carville and became a Public Health Service Hospital in 1921. Today it remains the only hospital in the continental United States devoted entirely to Hansen's disease.

The number of cases reported annually in the United States has remained fairly constant for most of the past 50 years, but began rising in the mid-1960s and reached a peak of 396 cases in 1981 according to Carville data. This recent rise has been due to cases among immigrants. Of 1,612 cases reported in the United States from 1951 to 1969, 58 percent of the persons were foreign born, while in 2,402 cases reported from 1970 to 1981, 84 percent were in foreign-born persons. From 1951 to 1969, an average of 35 cases among native-born persons were reported annually; from 1970 to 1981, it was 31 per year.

Several past investigations of Hansen's disease in the United States population as a whole have been reported, (*3,4*), but studies relating specifically to native-born citizens of the United States are limited. It was therefore felt it would be useful to study the characteristics of U. S.-born Hansen's disease patients in some further detail, and the purpose of this paper is to report some of these findings.

Materials and Methods

The data were collected from records at the National Hansen's Disease Center, where files have been maintained since 1894. For purposes of this paper, the term native-born citizens of the United States refers only to patients born in the continental United States. Hansen's disease in Hawaii has been discussed elsewhere (*5*). Cases in Hawaii are not included in this study. There have been 255 reported cases in native-born Hawaiians from 1951 to 1981, Carville disclosed.

The data encompassed nearly all the reported cases of Hansen's disease among patients born in the continental United States during the last 50 years. The data relating to age at diagnosis included 1,309 native-born persons with cases reported during the 50-year interval between 1932 and 1981. Information pertaining to classification, sex, race, and place of birth covers the 30-year period from 1952 to 1980 ;and includes approximately 740 cases. Sample size varied due to missing data in some categories. For the same period, only 466 cases were available for analysis regarding history of contact and occupation. A time series analysis of ages at diagnosis was performed on 50 years of data to study historical trends.

(It is recognized that the exact number of cases in the United States is not known, since there are cases that are not reported to the national register, and others, no doubt, are undiagnosed or misdiagnosed. However, it seems unlikely that this represents a large number of cases and that most would be paucibacillary and possibly self-healing.)

Results

Classification. Sixty-six percent of the cases belong to the multibacillary type (lepromatous and borderline), 31 percent to the paucibacillary type (tuberculoid and indeterminate), and in 3 percent of the cases the type was unknown (table 1).

Sex. Males comprised 62 percent, reflecting a male to female ratio of 1.63 to 1 among native borns. Among the males, 71 percent were multibacillary, 26 percent paucibacillary, and the remaining 3 percent were of unknown type. In the females, the comparable figures were 58 percent, 40 percent, and 2 percent (table 1).

Race. Eighty-nine percent were white, including Hispanics, 9 percent black, and the remaining 2 percent were southeast Asian or Chinese. The white to black ratio was 10 to 1. Thirty-one percent of all whites and 37 percent of all blacks had the paucibacillary form of the disease (table 1).

Place of birth. Patients born in Texas accounted for 56 percent of the total. Following Texas were Louisiana, 14 percent; California, 4 percent; Florida, 3 percent; and New York, 1 percent. Alaska, Maine, Massachusetts, Nevada, New Hampshire, North Dakota, Rhode Island, and South Dakota had no cases, and the remaining 22 percent came from the 36 other States and Washington, DC (table 1).

History of contact. Nineteen percent had a history of contact with Hansen's disease in the family, and 11 percent had a history of nonfamily contact. Thus, 30 percent of the cases had a prior history of contact. The majority of this 30 percent had multibacillary disease (table 1).

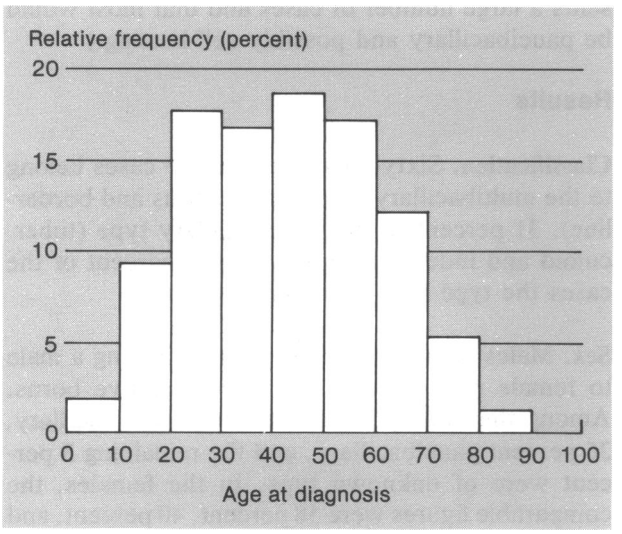
Occupation. Blue collar workers formed a 52 percent majority. Twelve percent had white collar jobs,

18 percent were housewives, and the remaining 18 percent were students, professionals, and unemployed persons (table 1).

Frequency distribution. The frequency distribution of ages at diagnosis is shown in figures 1 and 2, which graphically portray relative frequencies and cumulative relative frequencies. Seventy percent of patients were in the age group 20 to 60, while 11 percent were below 20 years and 19 percent above 60. The 25th and 75th percentile ages were 29 and 56 years. The median ages at diagnosis during different periods were as follows:

Periods	*Age*
1932–81	42 years
1932–56	39 years
1957–81	46 years

Figure 1. Age at diagnosis of native-born U.S. citizens with Hansen's disease, 1932–81



Time series analysis. The 5-year averages of ages at diagnosis from 1932 to 1981 are presented in table 2. The average age at diagnosis in 1932 was 40, and in 1981 it was 54.

The data were divided into two groups representing two consecutive 25-year periods—1932–56 and 1957–81. The relative frequency and the cumulative frequency distributions for the two periods are depicted in figures 3 and 4. These graphs display a pronounced shift in the distributions. A comparison between the curves for the periods 1932–56 and 1957–81 discloses that the arithmetic means increased from 40 to 46 and the skewness decreased from 0.26 to −0.06. To further examine this property, a time series analysis was performed on the data. The coefficient of correlation, which is a mea-

Table 1. Demographic characteristics of native-born Americans with Hansen's disease, 1952–81 (in percentages)

Category	*Number*	*Tuberculoid*	*Lepromatous*	*Borderline*	*Indeterminate*	*Unknown*	*All types*
Sex:							
Male	450	13.8	33.0	10.8	1.9	2.1	62
Female	281	13.1	15.9	6.4	2.1	1.0	38
Race:							
White	640	23.3	44.4	15.7	4.0	1.4	89
Black	64	3.3	3.4	1.2	0.0	0.8	9
Others	17	0.3	1.5	0.4	0.0	0.1	2
Place of birth:							
California	31	0.8	1.9	0.8	0.6	0.1	4
Florida	21	0.8	1.4	0.3	0.0	0.4	3
Louisiana	105	4.0	6.3	2.7	0.6	0.8	14
New York	7	0.7	0.3	0.0	0.0	0.0	1
Texas	410	14.3	28.8	9.6	2.3	1.0	56
Other States	158	6.1	10.4	3.6	0.6	1.0	22
History of contact:							
Family contact	89	2.1	12.0	3.6	0.8	0.4	19
Non-family contact	49	3.4	3.4	3.0	0.2	0.4	11
No contact	328	10.9	42.7	14.6	0.4	1.7	70
Occupation:							
White collar	56	2.8	6.2	2.8	0.2	0.1	12
Blue collar	242	7.7	30.7	11.3	0.6	1.5	52
Housewife	82	3.0	9.4	4.1	0.4	0.6	18
Others	86	3.0	11.6	3.4	0.2	0.2	18
Total		27	49	17	4	3	100

sure of the strength of the relationship between the age at diagnosis and the year, was found to be significant ($R = 0.92$). This observation indicated the suitability of a linear regression model. Figure 5 graphically illustrates the line of best fit whose equation is

$$A = 36 + 0.27X$$

where

A = Age at diagnosis and

X = Year starting in 1930

The equation shows that the average age at diagnosis in native-born citizens is increasing at the rate of 2.7 years per decade.

Age at first symptom and at diagnosis. A parallel analysis was made of a sample of 1,051 cases of native-born Hansen's disease patients where the ages at first symptoms were noted. The findings were strikingly similar to those obtained by the analysis of ages at diagnosis.

Discussion

The majority of native borns had the multibacillary form of the disease. This observation is consistent with the findings of Enna and coworkers (*3*) and Feldman and Sturdivant (*4*); in these studies, native and foreign-born persons were considered as a single population. The male preponderance is found in all countries (*6*). Enna and co-workers (*3*) reported a male to female ratio of 1.3 to 1. An Expert Committee of the World Health Organization in 1966 attributed this higher incidence in males to greater susceptibility rather than greater chances of exposure (*7*). The white to black ratio of 10 to 1 is not significantly different from that of the United States population. The percentages of whites and blacks who have the paucibacillary form of the disease is similar. This suggests that there is no significant difference in susceptibility in native-born whites and blacks.

More than half of the patients in this study were born in Texas. An explanation for this could be the greater chance of exposure to a larger number of Hansen's disease patients from Mexico (*8*). In Texas, the majority of patients are of Hispanic origin among both the indigenous and foreign born, while most of the remainder were white non-Hispanic, with a higher incidence among whites of German descent noted in some studies. Blacks, and other ethnic groups have a low prevalence of the disease in Texas (*4,8,9*). Mexico accounted for the largest number of foreign-born Hansen's disease patients in the United States (*3*).

Figure 2. Percent of cumulative relative frequency of the age of diagnosis

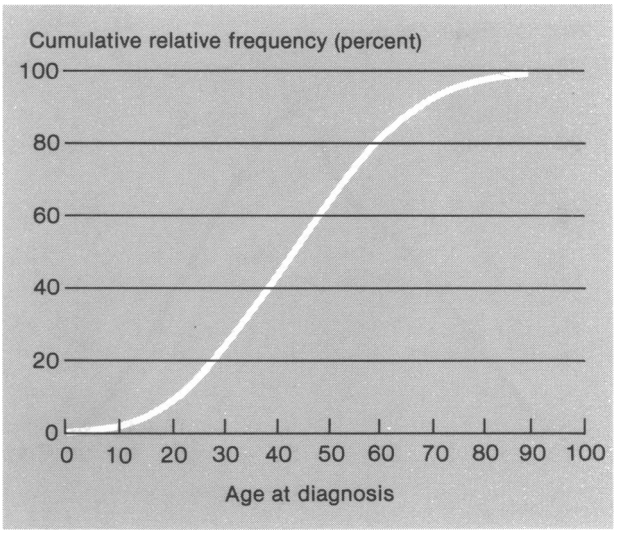


Table 2. Five-year means of ages at diagnosis of 1,309 patients with Hansen's disease, 1932–81

Period	Average age at diagnosis (years)
1932–36	39.5
1937–41	38.1
1942–46	38.7
1946–51	41.6
1952–56	42.5
1957–61	40.5
1962–66	44.8
1967–71	47.0
1972–76	46.8
1977–81	51.7

The percentage of patients who had a history of contact with Hansen's disease is comparable to those of Enna and co-workers (*3*), who determined that 25 percent of the cases had a history of contact. The incidence of Hansen's disease in families has been a topic of previous studies (*10*). A family history of contact is significant when present, but it is not a reliable indicator of exposure or susceptibility (*11*).

The findings pertaining to occupation indicate that Hansen's disease predominantly affects those of relatively lower socio-economic classes. However, this is not conclusive, since our study considered only occupation and not data pertaining to housing, income, and so forth.

Analysis of the data with regards to age at diagnosis showed a consistent trend toward increasing age

Figure 3. Comparison of relative frequency for two 25-year periods

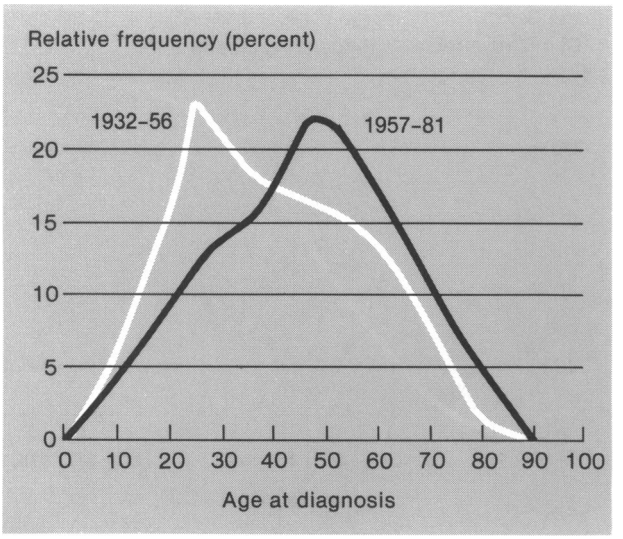


Figure 4. Cumulative relative frequency for two time periods

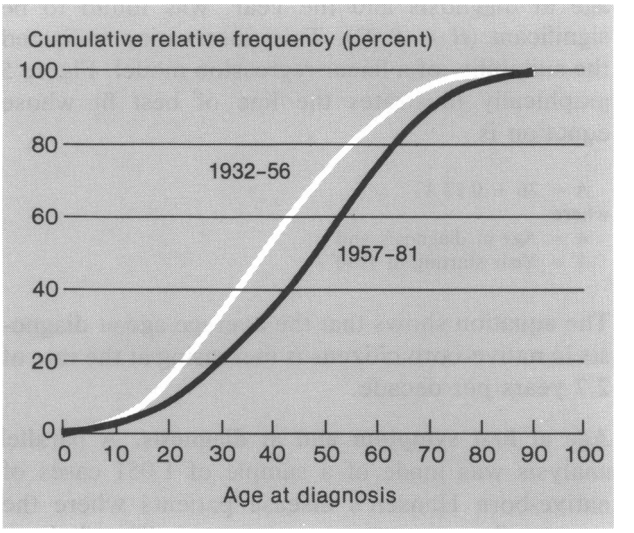
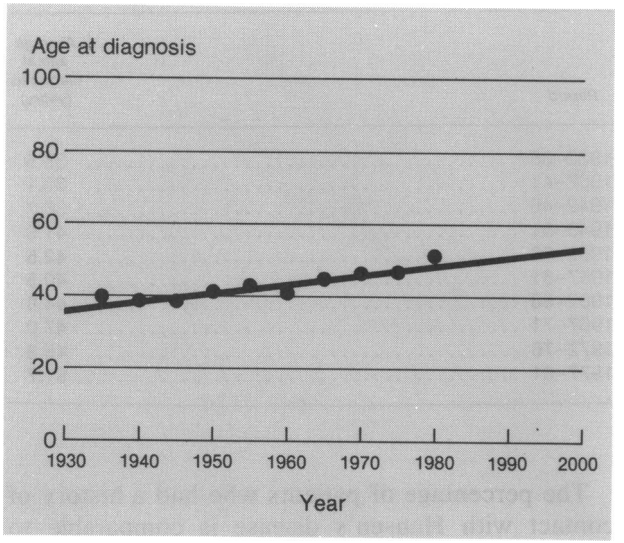


Figure 5. Ascending trend of age of diagnosis, 1930-2000



at diagnosis over the period under consideration. A comparison of the curves in figure 2 shows that the arithmetic means increased and the skewness decreased. This is an indication that the proportion of younger patients has been decreasing, an observation also found in Hawaii (*5*), Norway (*12*), and other locales where the incidence of nonimported cases was falling. The highest age at diagnosis found in the historical data is 90. Thus, as the average age at diagnosis rises toward 90, it can be inferred that the disease will gradually disappear. The trend established by the linear fit on the long-term historical data yields a conservative forecast, however. During the past two decades, the rate of increase in age at diagnosis has actually been greater than the long-term rate of 2.7 years per decade. This recent increase in upward trend suggested a curvilinear fit, and extrapolation based on a nonlinear trend would show that Hansen's disease would likely disappear earlier than when it was predicted by a linear extrapolation.

It is known that the period between onset of disease and diagnosis may be quite long at times, and thus one could question whether it is reasonable to draw conclusions from age of diagnosis alone. Data obtained from records of U. S.-born patients admitted to the National Hansen's Disease Center indicate that the average interval between onset of symptoms and diagnosis has been decreasing from approximately 6 years in 1966 to 2.5 years in 1982. This factor taken alone would be expected to reduce the age at diagnosis in contrast to the increase in age at diagnosis found in this study, and thus it also suggests that the trend we report here is a conservative one. The analysis of data from records of 1,051 U. S.-born patients admitted to NHDC, using age at first symptom rather than age at diagnosis, shows the trend of increasing age at the time of first time symptom to be very similar to the trend of increasing age at diagnosis in this study. These additional observations would seem to reinforce the validity of the trend reported in this study.

It is of some interest that the trend of increasing age at diagnosis has continued and accelerated in spite of the increase in cases among the foreign born in the past decade. Reasons for the increasing age at onset and at diagnosis are not known with certainty.

When there are relatively few cases, the disease will most likely be contracted in the community rather than in the household, and thus later exposure may be a factor. Irgens has also suggested that in a "dying epidemic" there will be a predominance of cases with a long incubation period which will be diagnosed later in life and therefore produce a trend of increasing age of onset of the disease (*12*). It has also been suggested that the increasing age at onset of disease may be due to a breakdown or decrease in immunity in older persons who had been exposed to the disease many years previously, as has been the instance with tuberculosis in the United States (*5*).

Though there has been a significant increase in cases of the foreign born, fortunately it is now possible to treat most of these patients quite adequately in their home communities, and prolonged hospitalization is no longer necessary. A series of government-funded clinics are located around the country to provide specialized care on an outpatient basis for Hansen's disease patients. These are currently located in Los Angeles, San Diego, San Francisco, Seattle, Phoenix, Staten Island, Boston, New Orleans, Miami, Chicago, and Honolulu. Several more may be opened in the future.

Conclusion

This study yielded a number of noteworthy findings. A majority of native Americans with Hansen's disease are born in Texas. The ratio of black to white persons with the disease is similar to the racial ratio of the total population, and, therefore, this suggests no significant difference in susceptibility. The majority of the cases were multibacillary, as previous researchers noted. Possibly the most interesting finding was the trend of increasing age at diagnosis over the 50-year period studied, with acceleration of this trend in the past two decades. This trend appears to be statistically significant and would predict the ultimate disappearance of Hansen's disease in native-born citizens, if the present trend continues. The noted trend is consistent with previous observations that Hansen's disease tends to disappear in countries with a high standard of living.

References

1. Badger, L. F.: Leprosy in the United States. Public Health Rep 70: 525–535, June 1955.
2. Trautman, J. R.: Epidemiologic aspects of Hansen's disease. Bull NY Acad Med 60: 722–731 (1984).
3. Enna, C. D., Jacobson, R. R., Trautman, J. R., and Sturdivant, M.: Leprosy in the United States 1967–76. Public Health Rep 93: 468–473, September-October 1978.
4. Feldman, R. A., and Sturdivant, M.: Leprosy in the U.S. 1950–1969. South Med J, 69: 970–976, (1976).
5. Worth, R. M., and Bomgaars, M. K.: Immigration and leprosy in Hawaii, 1960–1981. Int J Lepr 50: 335–341 (1982).
6. Park, J. E., and Park, K.: Textbook of preventive and social medicine. Ed 7. Messrs. Banarsidas, Bhanot, Jabalpur, India, 1979.
7. Chemotherapy of leprosy control programs: WHO Techn Rep Ser, No. 319 (1966).
8. Kluth, F. C.: Leprosy in Texas, a study of occurrence. Tex State J Med 51: 199–205 (1955).
9. Betz, T. G.: Hansen's disease. Texas Preventable Disease News, Oct. 8, 1983, pp. 1–4.
10. Badger, L. F.: Epidemiology. *In* Leprosy in theory and practice. Ed 2. Williams and Wilkins Co., Baltimore, 1964, pp. 69–97.
11. Levis, W. R., Schuman, J. S., Freidman, S. M., and Newfield, S. A.: An epidemiologic evaluation of leprosy in New York City. JAMA 247: 3221–3226, June 8, 1982.
12. Irgens, L. M.: Leprosy in Norway. Leprosy Rev 50 (supp.) 1: 114–120 (1980).