5 years) (El Paso Health Department, unpublished data, 1996). This decreased incidence, coupled with the lower rate of seropositivity in children in the less-than-first-grade age group, suggests that environmental improvements may be having a positive effect.

Hepatitis A is one of many fecal–oral diseases affecting families living in substandard housing developments. Vaccines can confer immunity against hepatitis A, but there are no vaccines for many enteric pathogens.[13] If there is to be a widespread impact on these diseases, efforts must focus on reducing fecal–oral transmission (e.g., by providing adequate excreta disposal and maternal education programs). This study suggests that recent improvements in San Elizario may have had a beneficial effect, but many areas are still substandard. □

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Diabetes in Hawaii: Estimating Prevalence from Insurance Claims Data

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ABSTRACT

Objectives. The purpose of this study was to determine the prevalence of diabetes mellitus in Hawaii from insurance claims data.

Methods. Information from two major health plans covering approximately 66% of the state's population was used to estimate prevalence rates by sex, age group, and geographic area. Weighted multiple linear regression was applied to identify predictors of diabetes prevalence.

Results. The statewide diabetes prevalence was estimated at 43.8 per 1000 persons. The ethnic composition of the population and rural residence partially explained the geographic variation in diabetes prevalence.

Conclusions. Insurance claims data may be a useful tool for population-based diabetes surveillance. (*Am J Public Health.* 1997;87: 1717–1720)

Introduction

Diabetes mellitus is an important cause of mortality and morbidity around the world.[1–3] Aging populations, early detection efforts, and prolonged life expectancy for diabetes patients contribute to an increasing prevalence. Surveillance is essential to evaluate public health strategies aimed at reducing the burden associated with diabetes. Diabetes prevalence rates in the United States[4] are based on self-reports from a National Health Interview Survey[5] population sample.

In Hawaii, the Health Surveillance Program,[6] the Behavioral Risk Factor Survey System,[7] and a screening study[8] have shown diabetes to be three to seven times more prevalent in Hawaiians and three to four times more prevalent in Filipinos and Japanese than in Whites. The high age-adjusted rate for diabetes as an underlying (31 vs 13.6 per 100 000) or listed (117 vs 53 per 100 000) cause of death among Hawaiians relative to all other ethnic groups suggests a disproportionately high fatality rate among Hawaiians with diabetes.

The present report estimates diabetes prevalence based on insurance claims; the advantage of this method is that a large proportion of the state's population, rather than a 1% to 2% population sample, is included. A similar approach has been used in Canada,[9] where a single-payer system provides a comprehensive data source. The geographic isolation of Hawaii, combined with high insurance coverage rates and a small number of health

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TABLE 1—Age-Specific Prevalence of Diabetes per 1000 Population and Estimated Proportion of Population Included in Prevalence Rates: Distribution by Age Group and Sex, Hawaii, 1992 through 1994

Age Group	Prevalence No.	Prevalence Rate, %	Estimated Population Covered	State Population, 1994	Coverage, %
0–19 y					
Male	268	2.6	103 455	173 600	60
Female	258	2.7	96 984	163 300	59
20–44 y					
Male	2 357	16.2	145 289	244 800	59
Female	6 158	40.6	151 701	223 500	68
45–64 y					
Male	7 733	92.2	83 849	112 400	75
Female	8 156	89.5	91 120	119 000	77
65+ y					
Male	6 587	134.5	48 958	66 000	74
Female	6 716	122.4	54 858	76 100	72
All ages					
Male	16 945	44.4	381 551	596 800	64
Female	21 288	53.8	394 663	581 900	68
Total no./overall rate	38 233	49.3	776 214	1 178 700	66

Note. The statewide rate, age-adjusted to the 1980 US population, was 43.8.

plans, favors surveillance based on insurance claims. The specific objectives of this study were to estimate the prevalence of diabetes mellitus in 1992 through 1994 by age, sex, and geographic area and to identify characteristics of areas with high diabetes prevalence rates.

Methods

The 1994 population of the seven inhabited islands of Hawaii was estimated at 1.18 million people[10] (24% White, 20.4% Japanese, 18.8% Hawaiian, 11.4% Filipino, 4.7% Chinese, and 20.7% "other"). As a result of (1) the Prepaid Health Care Act of 1974 mandating that employers provide health care coverage to their employees, (2) community ratings for insurance premiums, (3) low unemployment rates, and (4) the gap group insurance offered by the state,[11] approximately 96% of the state's population had health insurance in 1993.[12] Two thirds of the population was covered by two major health plans, a BlueCross BlueShield (BlueCross) insurer and a health maintenance organization (HMO); both provided data for this project.

The BlueCross insurer has maintained a diabetes registry among its membership since 1989, identifying cases through two or more insurance claims for office visits or hospitalizations involving *International Classification of Diseases*[13] codes 250.0–250.9 or 648.0 (up to December 1992). In the HMO, a list of potential cases identified through diabetes-related hospitalizations, elevated fasting glucose levels (>150 mg/dL), positive HbA_{1c} tests, or relevant prescriptions was unduplicated and was verified by the patient's physician through record review.

Membership data by sex, 5-year age groups, and zip code of residence were used as denominators. Only observations involving one of the 79 valid Hawaii zip codes[14] and nonmissing values for age and gender were used in analyses. Post office box zip codes were replaced with the closest area zip code. Age was classified into four groups (less than 20 years, 20 to 44 years, 45 to 64 years, 65 years and older). Prevalence rates for diabetes were calculated by dividing the number of cases by the number of insured persons in each group. Direct age adjustment was performed, with the 1980 US population as the standard. As a means of identifying low and high prevalence areas, standardized prevalence ratios were calculated by dividing the number of observed cases by the number of expected cases, the latter calculated as the sum of the products of the statewide age-specific rate and the number of persons per age group for each zip code. Standardized prevalence ratios above one indicated a higher diabetes prevalence than statewide, and ratios below one indicated a lower prevalence. Byar's approximation[15] was used to determine the statistical significance of the ratios.

Multiple linear regression analyses[16] used the stepwise selection method and incorporated population sizes as weights. These analyses were applied to investigate the relation between the standardized prevalence ratio (dependent variable) and demographic variables (predictors); the latter were extracted from the 1990 census zip code data file (Summary Tape File 3B[17]). Data analysis was performed with PC-SAS (SAS Institute, Cary, NC); Atlas GIS (Strategic Mapping, Santa Clara, Calif) was used in geographic mapping.

Results

Among the 776 214 members of the two health plans, 38 233 cases of diabetes were identified. The statewide prevalence rate for diabetes during 1992 to 1994 was estimated at 43.8 per 1000 persons (based on approximately 66% of the state's population) (Table 1). Coverage rates differed by age, the highest representation (76%) being among those 45 to 64 years of age and the lowest being in men less than 44 years old and women less than 20 years old (59% to 60%). Age was a major determinant of diabetes prevalence, with rates rapidly increasing after 44 years of age (Table 1). Prevalence rates did not differ significantly by sex, except in the 20- to 44-year age group.

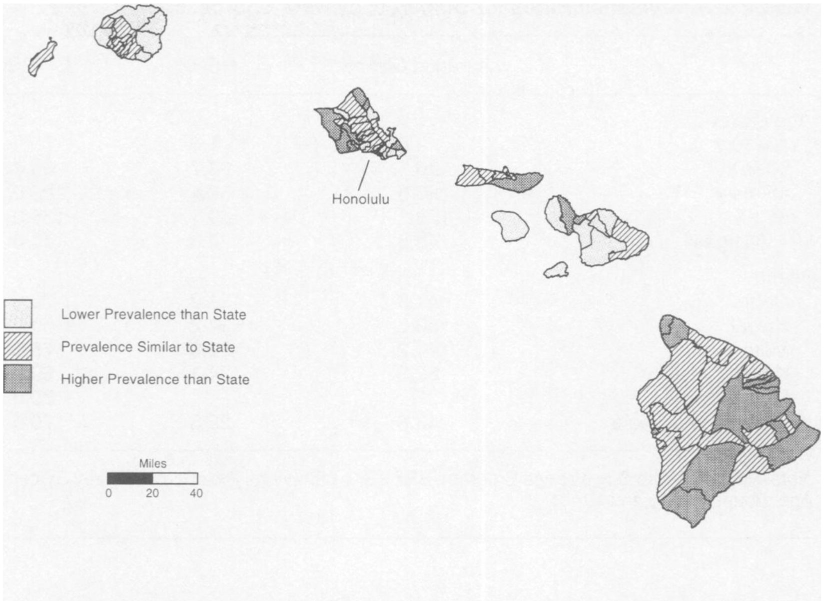
Standardized prevalence ratios (range: 0.3 to 2.0) varied among zip code areas (Figure 1); a higher prevalence was seen on the island of Hawaii, and a lower prevalence was observed on Kauai. Prevalence rates were significantly higher than the statewide rate in 23 zip code areas. The regression results indicated that 38% of the variation in prevalence by zip code could be predicted by rural residence (3%) and by proportion of Hawaiians (29%) and Whites (6%) in the population. Diabetes prevalence was directly related to proportion of Hawaiians and inversely related to proportion of Whites. The percentage of Hawaiians was significantly higher in rural areas (21% vs 11%), whereas the percentage of Japanese was significantly higher in urban areas (25% vs 16%). Figure 2 shows the percentage of Hawaiians in the population, by zip code area.

Discussion

The diabetes prevalence rates estimated here lie between the Behavioral Risk Factor Survey System and Health Surveillance System estimates (see Table 2). Methods of data collection may explain these discrepancies. The Health Surveillance System collects health information from a sample of approximately 6000 households,[18] and one person reports the medical conditions for all family members including children, a method that is likely to miss some cases. The Behavioral Risk Factor Survey System conducts approximately 2000 telephone interviews among adults only; this method produces unstable regional rates. Selection bias resulting from low participation rates may explain the high morbidity among the survey system participants. The finding that diabetes prevalence is related to the proportion of Hawaiians in the population agrees with the results of previous surveys and with the high mortality rate associated with diabetes in this group. The high diabetes prevalence on the island of Hawaii (Table 2) is a result of the large Hawaiian population there (Figure 2). Variations in diabetes prevalence rates not explained by ethnicity may be due to obesity, lack of physical activity, and different levels of early detection efforts, all common among the Hawaiian population.[19] Given the large number of residents aged 20 through 44 years, diabetes prevalence in Hawaii will increase as this cohort grows older.

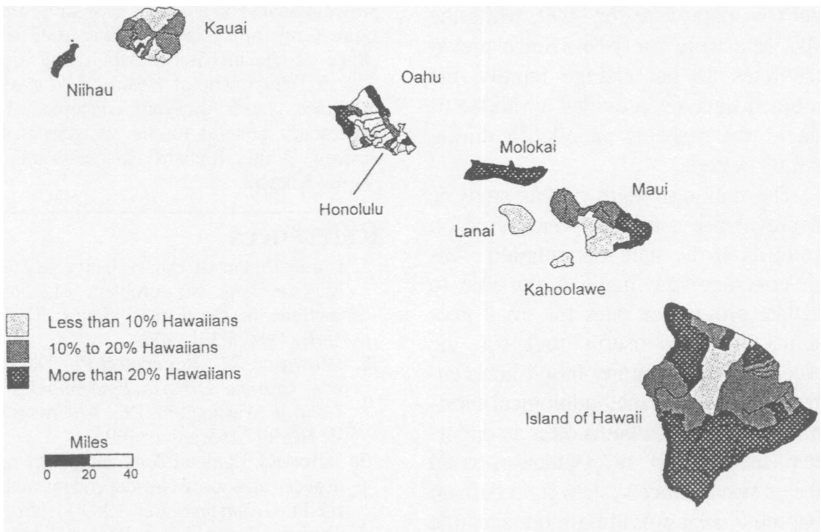
Lack of information for 34% of the population limited this study. Fortunately, 30% of Medicare beneficiaries (individuals on cost contract plans with the two health plans) were included. Whereas individuals covered by the military or other health plans are unlikely to differ in terms of their diabetes risk, Medicaid and uninsured patients may be at increased risk. The small size of the Medicaid population would have a relatively small influence on statewide prevalence. In regard to the uninsured population, Behavioral Risk Factor Survey System data for 1993 indicate that the diabetes prevalence among persons without a health plan was lower than that among insured persons (1.5% vs 5.2%). Future expansion of this data system to include names for follow-up across health plans and to add claims from the remaining insurance carriers would create a system that could provide incidence and complication rates. Lack of information on ethnicity and obesity (both major determinants of diabetes[3,20]) on insurance claims is a serious problem. Linking insurance claims with vital records data may provide ethnicity data for a major portion of the population in the future.

The rates for the BlueCross population may have been underestimated because individuals with more than one health plan were counted more than once, resulting in a slightly inflated denominator. On the other hand, the numerator was probably inflated because diagnoses were not verified among members of BlueCross. Diagnostic codes may have been used for



Note. Prevalence rates are based on insurance claim information for 66% of the population.

FIGURE 1—Prevalence of diabetes, by zip code area: Hawaii, 1992 through 1994.



Source. Population data are from the Hawaii Department of Business Economic Development & Tourism.[10]

FIGURE 2—Percentage of Hawaiians in the population, by zip code area: Hawaii, 1992 through 1994.

TABLE 2—Prevalence Rates for Diabetes, by Data Source: Hawaii, 1992

	Insurance Claims	HSP[a]	BRFSS[a]
Age group			
0–19 y	2.6	1.0	...
20–44 y	28.7	7.7	39.4
45–64 y	90.8	57.4	105.9
65+ y	128.1	69.1	135.0
All ages	43.8	22.3	70.0
Island			
Oahu	41.8	21.2	72.0
Hawaii	63.6	24.2	50.0
Maui	41.2	23.0	75.0
Kauai	32.6	34.1	69.0
Molokai/Lanai	...	...	79.0
State as a whole	43.8	22.3	70.0

Note. HSP = Health Surveillance Program; BRFSS = Behavioral Risk Factor Survey System.
[a]Age groups 0–17 y and 18–44 y.

reimbursement purposes (e.g., justifying diagnostic procedures to rule out diabetes). The high rate for women 20 to 44 years of age suggests a miscoding of gestational diabetes in the BlueCross data, since prevalences among female HMO members were similar to those among male members. For technical reasons, the BlueCross data were for 1992, while the HMO data were for 1994. Since prevalence rates do not change rapidly, the combined data set provides a valid estimate of the diabetes prevalence during this time period.

The major strength of this study is that prevalence estimates were based on two thirds of the state's population. This high coverage rate made it possible to calculate prevalence rates for small geographic areas, a useful tool for the evaluation of community-based interventions. Despite some methodological shortcomings, insurance claims offer an opportunity to develop a population-based diabetes surveillance system for a defined geographic area, providing more accurate estimates than population surveys and doing so at a lower cost than diabetes registries that require medical chart review. □

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