Area-Level Predictors of Use of Prenatal Care In Diverse Populations

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Synopsis ....

Patterns and predictors of the use of prenatal care in Hawaii were examined by census tract, taking into account summary measures of socioeconomic status, environmental conditions, and aggregated indicators of pregnancy-related risk characteristics of mothers. The objectives of the study were to identify those census tracts with high levels of inadequate use of prenatal care services; to develop a model, based on census tract characteristics, to explain observed geographic variations in the use of prenatal care services; and to indentify for further investigation specific localities with unanticipated patterns of use.

Data were drawn from 1980 census reports and vital statistics live birth files for the period 1979–87. Regression analysis was used to develop a model that was able to predict 61 percent of the census tract variation in the percentages of inadequate use of prenatal care services. Increased proportions of mothers of Japanese and other Asian-descent and of adults with more than high school education were associated with low levels of inadequate use of prenatal care services. Increased proportions of high parity-for-age risk and Samoan mothers were associated with higher levels of inadequate use. Census tract maps of actual and predicted percentages and studentized residual values were used to identify areas with high and low rates of inadequate use of prenatal care services. The area-level methods used are believed applicable to health care planning in other areas with ethnically or socioculturally diverse populations.

L‌OW BIRTH WEIGHT and other adverse outcomes of pregnancy often are associated with inadequate use of prenatal care services (1–5). Improving access to and use of prenatal care has been promoted specifically to reduce the prevalence of low birth weight (6–11). Variations in the patterns of use of prenatal care services have been associated with maternal sociodemographic, economic, medical, cultural, and behavioral characteristics (3–23). Locality-specific health care system factors, such as capacity, availability, and convenience, are possible barriers to access to prenatal care (6, 13, 17–23).

Typically, studies of the use of prenatal care services have examined individual case-level data, which often are State vital record files or clinical data bases (1, 3, 5, 15). Those data bases often lack detailed information on the social setting, environment, living conditions, and the community where the women reside. Using such data bases, potentially important predictors of variations in the use of prenatal care services may be missed, resulting in underspecified and biased models of use (24).

Mortality, morbidity, and their contributing factors are not uniformly distributed among populations or geographic areas. As a result, their distribution reflects complex interrelationships of the characteristics of a locality and of its inhabitants. The usefulness of combining information on people with information on the socioeconomic and environmental characteristics of their residential area has been suggested (25). Few studies have been made using such a design, particularly small area variations in the use of prenatal care services (26).

We investigated area-level predictors of variations in the use of prenatal care services using census tracts. We used summary measures of socioeconomic status and environmental conditions and aggregated indicators of the sociodemographic and pregnancy-related medical risk characteristics of the mothers residing in those areas.

> *'The use of area-level analyses to guide programmatic activities is indicated when the goal is to evaluate the effectiveness of a population intervention or when the influence of community characteristics is part of the study design.'*

Methods

The unit of analysis was census tracts, rather than persons, in the State of Hawaii. Census tracts are defined specifically to be small enough to capture demographic, social, and economic homogeneity, but large enough to be useful for statistical analysis (27). Data on both health and social characteristics are coded by census tract. Summary indicators were selected for poverty level income, educational attainment, employment, and the numbers of household members per room from 1980 census reports. Data measuring maternal sociodemographic and medical risk and the level of use of prenatal care services were extracted from the Hawaii 1979–87 vital record live birth files for 162,000 single, live births. The risk factors were sociodemographic risks, the level of use of prenatal care services, and medical risks.

Vital record data for a 9-year period were used to minimize unstable fluctuations associated with small numbers of subjects and to reduce the influence of unusual, short-term trends. Summary percentages were calculated for each variable for each census tract, such as the percentage of live births to mothers with inadequate use of prenatal care services.

Because the study was designed to predict area rather than individual or population variation among dependent variables, equal weight was given to each tract. Accounting for the number of births per tract would have given undue weight to the maternal variables at the expense of contextual variables. This would have risked allowing tracts with large numbers of births to drive the model. There were no independent variables that were specifically correlated with the size of the census tract population. The median number of births in the tracts was 700. After eliminating 6 tracts that had fewer than 30 live births during the 1979–87 period, 155 tracts were included for study.

We measured the adequacy of the use of prenatal care according to a modified version of the Insti-

tute of Medicine's Prenatal Care Index (1, 28). Adequacy of care was assessed by indexing the trimester that prenatal care began and the number of prenatal care visits, accounting for the gestational age of the fetus at birth.

To identify areas associated with the most serious deficits in the use of prenatal care, we selected as the outcome variable the proportion of women who did not use prenatal care or who showed inadequate use, as indicated by beginning care in the third trimester or by a marked insufficency of visits.

Table 1 lists the independent variables that were included for maternal and population characteristics, which were obtained from separate sources. Stepwise multiple regression analysis was used to develop a preliminary model to predict variations in percentages of inadequate use. Stepwise regression is considered an efficient method of identifying a small subset of significant predictors from a large set of variables (25).

The findings were examined together with the results of an analysis of Pearson correlation coefficients to assess possible multicollinearity among the variables. Multicollinearity may occur when two variables measure the same concept, or are associated with each other, causing difficulties in identifying the amount of variation in the dependent variable that is explained by each of the affected variables (29). The presence of multicollinearity suggests the need to eliminate one of the affected variables from the model, based on an assessment of the importance of each affected variable to the hypothesized relationship, the strength of the association of each variable with the dependent variable, and the accuracy of the data used to construct the variable.

A final multiple regression model was used to generate actual, predicted, and studentized residual values of inadequate prenatal care for each census tract. All independent variables included in the final model were significantly associated with the percentage of inadequate use of prenatal care at a level of less than 0.05. Observed, predicted, and studentized residual values of inadequate prenatal care for each census tract were used to create statewide maps showing patterns of inadequate use of prenatal care, patterns predicted by the regression analysis, and residual tracts. Residual values provide the differences between the observed and predicted levels of inadequate use of prenatal care in each census tract. Studentized residuals adjust the residual values by dividing them by their standard errors. Negative values indicate that the

value observed was less than the value predicted.

Census tracts, with residual values that were greater than two or less than minus two, were of particular interest. Residual values of this magnitude indicated census tracts with considerable disparity between the observed level of inadequate use of prenatal care and the predicted level, suggesting that variables other than those included in the analysis may have influenced the pattern of use. Further study is needed of deviant tracts.

Results

Percentages of inadequate use of prenatal care ranged from 1.9 to 19.8 percent, with an average of 7.6 percent. Eight percent of census tracts had inadequate use percentages of 15 or more. Inadequate use percentages of less than 5 were found for 30 percent of the tracts. Levels of inadequate use of 15 percent or more were predicted for 1 percent of the tracts. Values of less than 5 percent were predicted for 23 percent of the tracts. Maps of the observed and predicted percentages of census tracts, and of residuals, were created for each county. Mapping is an effective method for visually presenting the results of regression analysis. The method may be useful for health services planners in other States with diverse populations. Copies of maps are available from the authors. Table 2 shows the results of the regression analysis and displays those variables that were found to be significant ($P < 0.05$).

The independent variables predicted 61 percent of the variation among census tracts in the percentages of inadequate use of prenatal care. Large proportions of Samoan mothers and of mothers considered at high parity-for-age risk were associated with high levels of inadequate use of prenatal care among census tracts. High percentages of mothers who were of black, Japanese, and other Asian ethnicity, and of adults in the total census tract population with more than a high school education, were associated with lower levels of inadequate prenatal care. No other socioeconomic status, maternal medical risk, or sociodemographic variable contributed significantly to explaining patterns of inadequate use of prenatal care.

Discussion

The study was designed to locate census tracts with relatively high levels of inadequate use of prenatal care and to identify community-level factors associated with those patterns. Maternal ethni-

Table 1. Characteristics of mothers and of the population of census tracts in Hawaii, shown in percents

Variable	Range	Mean	Median
Maternal characteristics			
Inadequate prenatal care[1]	1.9–19.8	7.6	6.4
Caucasian	1.6–72.9	28.4	24.2
Hawaiian	1.1–70.5	23.2	21.3
Filipino	1.9–68.2	16.7	11.4
Japanese	0.8–46.1	15.4	12.0
Samoan	0.0–37.9	2.2	0.8
Black	0.0–20.9	1.7	0.5
Other Asian	0.0–48.1	9.2	4.8
Younger than 18 years	0.0–12.1	3.0	2.7
35 years and older	1.7–24.9	8.3	7.7
Single	2.1–47.0	19.9	19.1
Low educational attainment[2]	1.0–31.3	11.4	9.7
High educational attainment[3]	11.5–87.1	44.3	42.7
Not U.S.-born	1.0–64.2	23.9	19.6
High parity-for-age risk[4]	6.0–33.3	18.1	18.1
Any previous fetal death	18.1–39.4	28.1	28.3
Population characteristics			
Not-U.S.-born	3.6–55.2	17.1	14.1
Adults with less than 12 years of education	6.2–55.2	29.4	27.8
Adults with more than 12 years of education	6.8–83.6	36.0	34.5
Unemployed adults	0.0–9.0	2.9	2.9
Family income less than 125 percent of poverty level	0.0–49.4	12.9	10.7
Household has more than 1.1 persons per room	2.9–52.3	16.5	14.4

[1] Reference 1.

[2] Low educational attainment is defined as less than 12 years of education for adults and 2 years below the expected grade level for age for those younger than 18 years.

[3] High educational attainment is defined as more than 12 years of education for adults and 2 years above the expected grade level for age for those 18 and older.

[4] High parity-for-age risk is women younger than 18 years, women 40 years and older, women 30 years and older having a first birth, and women 18 or 19 years old with 1 or more previous live births.

NOTE: Maternal characteristics are derived from 1979–87 vital records. Population characteristics are derived from the 1980 census.

city explained a large proportion of the variation. High concentrations of black mothers showed strong positive association with low percentages of inadequate use of prenatal care. The association is noteworthy and warrants further investigation, particularly in view of the important issue of underutilization of care among black mothers. Military families account for a large proportion of births to black mothers in Hawaii. These findings may reflect military families' access to the armed services' system of prenatal care through health services.

Given the diverse cultural background of Hawaii's multi-ethnic population, traditional pregnancy care practices may be an important consideration in interpreting these findings. While not called prenatal care, and not recorded on State vital records, many Samoan women participate in

Table 2. Predictors of inadequate use of prenatal care in Hawaii census tracts, derived by multiple regression analysis

Independent variable	Parameter estimate	P-value
Intercept of regression line.........	9.15	0.0001
Percent black mothers..............	−0.23	0.0060
Percent Samoan mothers	0.10	0.0200
Percent Japanese mothers.........	−0.15	0.0001
Percent other Asian mothers	−0.08	0.0030
Percent of adult population of the census tract with more than 12 years of education................	−0.08	0.0001
Percent of mothers at high age-for-parity risk[1]......................	0.26	0.0001

[1] High parity-for-age risk is women younger than 18 years, women 40 years and older, women 30 years and older having a first birth, and women 18 or 19 years old with 1 or more previous live births.

NOTE: R^2 of model = 0.61, F value = 38.51, probability of F = 0.0001

community-based, nonmedical pregnancy care (personal communication, Nina McCoy, Program Coordinator, Kalihi-Palama Health Clinic, Honolulu, HI, September 1991). This practice may contribute to the significant association shown between Samoan ethnicity and high levels of inadequate use of prenatal care. Similar processes may occur in communities outside Hawaii with large Hispanic, Caribbean, Asian, Native American, or other ethnic or immigrant populations.

In a census tract, the percentage of adults with more than a high school education was significantly associated with low levels of inadequate use of prenatal care, while the aggregated percentage of mothers with more than 12 years of education was not significant.

The characteristics of the total community environment may transcend the characteristics of specific persons within the community and exert an influence on subgroup behavior (29–30). High education levels in a community often are associated with increased access to information and a receptiveness to ideas that have originated outside the community. In this manner, high levels of education throughout the census tract may influence pregnancy-related behaviors and peoples' perceptions of the importance of using available preventive health care services.

Census tracts with high percentages of mothers with high parity-for-age risk were likely to have high percentages of inadequate use of prenatal care. Financial constraints and the need to provide child care may make care seeking more difficult for multiparous women (13). Further, multiparous women may perceive pregnancy as normal and not a condition requiring extensive use of medical care services.

With the exception of the level of education, indicators of socioeconomic status, poverty, crowding in housing, and unemployment were not significant predictors of inadequate use of prenatal care. Instead, the ethnic characteristics of the census tract played a major role in explaining variations in prenatal care use. The findings emphasize the importance of understanding the cultural and behavioral factors influencing the use of prenatal care in the census tracts. Recent efforts to encourage the development of culturally appropriate maternal and child health programs are supported by these results.

Only 6 percent of the census tracts in the study had substantial residual values, suggesting a relatively good fit of the statewide model at the census tract level. There was no systematic pattern of residual tracts. However, several tracts with substantially underpredicted levels of inadequate prenatal care had very low proportions of births from the predictive ethnic groups.

Of interest for the purpose of health service planning and possible future investigation was the identification of three tracts for which the levels of inadequate use of prenatal care were substantially lower than expected. Those tracts were characterized by extremely low percentages of persons with more than a high school education and high percentages of mothers not born in the United States, which are usually characteristics suggesting barriers to use of services.

Much of what is known about the use of prenatal care services has been based on studies that focus on the individual as the unit of analysis. If outreach efforts are initiated in specific localities, person-level analyses may not indicate the effects of community-based interventions. The use of area-level analyses to guide programmatic activities is indicated when the goal is to evaluate the effectiveness of a population intervention or when the influence of community characteristics is part of the study design (29). Area-level analyses contribute to program planning by identifying relevant social and environmental characteristics that may influence individual decisions to seek health care (31). They permit including measures of community socioeconomic status that may not be available from individual-level data, such as vital statistics.

Significant differences in ethnic variables reflect Hawaii's diverse racial and ethnic composition. However, the process of area-level study is particularly useful wherever there are geographic variations among ethnic, sociodemographic, or utilization characteristics. Replications of this study,

using similar variables in other locations, will contribute to identifying the usefulness and limitations of area-level analysis in locations with diverse populations.

Caution should be used in interpreting area-level and population-level studies to avoid the ecological fallacy, that is, drawing cause-and-effect conclusions or using group findings uncritically to infer variations in individual behavior (24, 29-32). Individual-level analyses, particularly when underspecified, also may lead to spurious conclusions. The goals of each research approach differ, and findings must be interpreted with a critical view of the potential limitations of each. Strategies considered appropriate for conducting area-level research include using regression techniques, developing a model using all the logical risk factors and characteristics of the group to avoid underspecified and biased models, and using the smallest possible geographic unit of analysis to improve group homogeneity, while maintaining sufficient population size for statistical analysis (24, 29, 32).

Care should be used in inspecting maps based on data aggregated by geographic area. A small number of large areas may distort perception of the extent of risk, or the lack of it, in comparison with a large number of small tracts that cover a smaller area. The geographic extent of risk, compared with the density of risk, is of specific interest when considering the possible impact of location or distance on use of services. The values provided by data for an area do not represent the actual location of the population within the area, but rather are presented uniformly for the entire area. Clusters of occurrence of inadequate use of prenatal care may actually be split between two or more adjacent areas, diluting the apparent intensity of the problem in some heterogeneous areas. This is less of a problem within census tracts than within larger, more commonly used, health planning areas.

The concept of identifying high-risk communities for focused interventions has received renewed impetus by the need assessment requirements of the Title V Maternal and Child Health Services Block Grant Program (33). Other Federal program initiatives, such as Healthy Start, have directed attention to identifying localities with poor pregnancy outcome indicators and low levels of use of health services. Information from area-level studies may be used to identify subcommunities for indepth need assessments, including identifying pregnancy-related beliefs and practices and ultimately assisting program directors to effectively focus preventive resources and intervention strategies.

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Maternal Pregravid Weight, Age, and Smoking Status as Risk Factors for Low Birth Weight Births

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Synopsis ....

The Illinois Department of Public Health, in cooperation with the Centers for Disease Control (CDC), monitors trends in the prevalence of prenatal risk factors that are major predictors of infant

mortality and low birth weight (LBW). Analyzed data from CDC are available to the department annually. During 1988, a total of 26,767 records of Illinois women giving birth were submitted to CDC. These surveillance data support the fact that women older than 30 years who smoke and enter pregnancy underweight are at greatest risk of delivering LBW babies. Overall, 13.9 percent of underweight smokers had LBW infants compared with 8 percent of underweight nonsmokers.

Prevalence of LBW among underweight and smoking women older than 34 years was much higher (29.6 percent) than among those between ages 30 and 34 (15.2 percent). The prevalence of LBW decreased as the pregravid weight increased among normal weight smokers (10 percent) and overweight smokers (8.6 percent).

FACTORS EXISTING BEFORE PREGNANCY and factors occurring during pregnancy have extensive influence on the condition of the infant at birth. Since birth weight has a strong correlation with infant survival (1–3), attention has been given to strategies that will reduce the proportion of infants with low birth weight (LBW), defined as less than 2,500 grams (g). Similar to national patterns (1), the infant mortality rate in Illinois has decreased from 25.0 deaths per 1,000 live births in 1960 to