Estimating Population Size for Micro Minority Population Groups: Denominator Estimation for the Measurement of Mortality Patterns among US Pacific Islanders: 1992-2005

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Abstract

Like many small populations, measuring health disparities among Pacific Islanders is limited by the lack of reliable population estimates. The lack of baseline denominator information is unfortunate, as small populations, such as the Native Hawaiian and other Pacific Islander (NHOPI) groups can face significant health challenges, particularly in terms of endemic and chronic conditions such as diabetes and hypertension. Without denominator population estimates, we cannot accurately examine either the risks of the disease process or the potential cost of disease to the health care system. This paper presents a statistical approach to estimating NHOPI population size on an annual basis, and also presents an analysis of the impact of biracial and multiracial self identification in the 2000 Census of population. We present a series of re-weighted population estimates that identify the growth of the NHOPI population between 1990 and 2000 from the perspective of the 1990 and 2000 definitions.

Introduction

Like many small populations, the measurement of health disparities among Pacific Islanders is limited by the lack of reliable population estimates. Without the presence of annual population estimates it is virtually impossible to generate reliable rates of disease processes, mortality, life table functions, or even simple crude measures such as death and birth rates. This lack of baseline denominator information is unfortunate, as small populations, such as the Native Hawaiian and other Pacific Islander (NHOPI) groups can face significant health challenges, particularly in terms of endemic and chronic conditions such as diabetes and hypertension. Without denominator population estimates, we cannot accurately examine either the risks of the disease process or the potential cost of disease to the health care system. This paper presents a statistical approach to estimating NHOPI population size on an annual basis, allowing costs to generate realistic incidents and occurrence rates of disease and mortality. This paper also presents an analysis of the impact of biracial and multiracial self identification in the 2000 Census of population. We present a series of re-weighted population estimates that attempt to identify the growth of the NHOPI population between 1990 and 2000 both from the perspective of the 1990 definitions and the 2000 definitions.

Objectives

1. Present an estimation approach to project the size of the Pacific island population in the United States. This allows us to establish baseline information necessary to perform rates ratios and life table measures to allow analysis of NHOPI health, specifically patterns for Native Hawaiians and other major Pacific island populations
2. Use the denominator estimates resulting from this technique to provide evidence-based results on mortality patterns and health risks that can guide policy and intervention programs to reduce and eliminate health disparities
3. Present techniques that address the distortions introduced by the measures of multiple race introduced by the 2000 Census and provide examples of different re-weighting approaches that provide a more uniform population estimates.

Literature Review

The significance of the proposed study is driven by the lack of baseline information on the health of Pacific Islanders, the growing recognition of the need to better understand the current health of minority populations and the federal mandate to eliminate health disparities by the year 2010 (www.health.gov/healthypeople/document/). Prior federally-sponsored conferences on the health of the Pacific Islander population have documented the lack of information on the health of Native Hawaiian and other Pacific Islanders and the negative consequences of this deficit on health policy and planning, development of effective intervention programs and ultimately improving the welfare of Pacific Islanders (Office of Minority Health, 1996; NHPI Alliance, 2007; Ro & Kagawa-Singer, 2007, Panapasa, 2007)

Infant Mortality. Infant mortality is often seen as a defining measure of a country’s health (IOM, 1985) and an examination of the patterns of infant deaths among Pacific Islanders will represent a central aspect of our mortality analysis as it relates to Aim 1 of the proposal. Even though the infant mortality rate in the United States reached a historic low of 6.8 deaths per 1,000 live births in 2001 (NCHS, 2003), the US rate remains higher than that of most major industrialized countries (MacDorman et al., 2002). There is marked variation in infant mortality rates by racial and ethnic group as well as geographically across the United States with minority groups often reflecting much higher rates than that seen for whites (Hummer, 1993; 1999b; Frisbie et al, 2004; Hessol & Fuentes-Afflick, 2005). This has clear implications for our study of Pacific Islanders, particularly in light of how little we know about infant mortality of this population.

All three Pacific Island groups identified as target populations in this application (Native Hawaiian, Samoan and Guamanian) have been cited as having low levels of prenatal care among mothers of newborns (Mor et al, 1995). Only 76 percent of Native Hawaiian women in Hawaii received prenatal care in the first trimester compared to the US average of 83 percent; for Guamanians only 63 percent of mothers received prenatal care and among Samoans only 52 percent did, the lowest rate among any ethnic or racial group in the United States (Asian and Pacific Islander Health Forum, 2003). Both Native Hawaiians and Guamanians report high rates of teen births with 57 percent of all infant deaths among Chamorros in Guam being born to teen mothers as of 1994 (APIAF, 2003a; 2003b; 2003c). While there are clear indicators that suggest birth weight, smoking, poor prenatal care and low SES all play an important role in infant mortality among Pacific Islanders (Lin-Fu, 1988; Yu & Liu, 1992), the proposed study will provide updated information as to the best of our knowledge no one study has systematically addressed these issues.

<u>Socioeconomic Status and Health.</u> Socioeconomic, ethnic and racial disparities in health outcomes in the U.S. and other societies represent a major challenge to health systems and a growing social concern (Pappas et al, 1993; Williams & Collins, 1995; Krieger, Chen & Ebel, 1997). The impacts of disparity on quality of life and longevity are among the most significant public health problems currently facing our society (Adler et al., 1994; House & Williams, 2000; Marmot 2002). Appropriately, the goal of understanding and reducing social inequalities in health has assumed a top priority for the Public Health Service and the National Institutes of Health in defining their mission and goals in the new millennium (Varmus, 1999; DHHS, 2000; NCI, 2001). Differences in health outcomes as measured by variations in both socioeconomic status and racial or ethnic diversity represent one of the major determinants impacting health trajectories across the life course. These differences measurably impact the degree to which individuals and populations can and do achieve increases in longevity and measurable reductions in chronic morbidity and functional limitations. Research indicates that the impacts of socioeconomic differences on health vary over the life course; being largest in infancy and early childhood, smaller in adolescence and early adulthood, then progressively increasing throughout middle and early old age before finally declining again in later old age (Antonvsky, 1967; Rogot, 1992; House et al., 1994; Beckett, 2000). Persons in the US who experience low SES status routinely face the kinds of health problems in early middle age that are not commonly observed among the high SES population until 30 to 40 years later (House et al., 1990).

<u>Research Areas Addressed by this Analysis.</u> Most federal reports on the health of Pacific Islanders continue to aggregate the results for Pacific Islanders with Asians. This is problematic as the numerically large groups mask the results of the numerically smaller subgroups. Further the rates when aggregating the results for Pacific Islanders do not accurately represent the outcomes for Pacific Islanders and are often bias toward the larger groups. The proposed project will overcome these limitations by calculating separate results for select Pacific Islander subgroups.

The work of Edith Kieffer, one of the leading researchers on infant and maternal health among Hawaiian and Samoan populations is an example of the kinds of challenges this proposal hopes to address. Kieffer has worked with vital statistics data (Kieffer, et. al., 1995), census data (Kieffer, et. al., 1993) and survey data (Kieffer, et. al., 1994) and while representing foundation research on these issues, the lack of reliable denominator information seriously impacts the ability to infer results beyond the study populations generally located in Hawaii. The proposed project will build on Kieffer's work by generating population estimates for the annual N ative Hawaiian and other Pacific Islander U.S. populations, as well as, the key Hawaiian, Samoan and Guamanian subpopulations allowing for a more detailed examination of infant and maternal health patterns over the past 15 years and provide useful baseline information on not only occurrence, but prevalence and risk, a factor we currently know little about. Further the detailed analysis will provide intra- and inter-group comparison.

Research Design:

Data Sources. The data used in this study is derived from three sources: 1) mortality detailed files for Native Hawaiian, Guamanian and Samoans in the United States; 2) linked birth/infant death data for the three subgroups; and 3) U.S. census 1990 and 2000. The data sources, total infant deaths and total population are provided in Table E.1. The infant mortality data are extracted from NCHS Vital Statistics data sets. These files are obtained from the Inter-University Consortium for Political and Social Research (ICPSR), an affiliate within the Institute for Social Research (ISR) at the University of Michigan. Annual population estimates for Pacific Islanders will be derived using standard demographic techniques for intercensal estimation between the 1990 and 2000 Census of population. Special tabulations from the 1990 population census developed by the US Census Bureau for Panapasa provide 100 percent population information for Native Hawaiians, Samoans and Guamanians and extracts from the 2000 Summary File 2 (SF2) provides the same information for the 2000 population census.

Multiple Cause of Death (1990 to 2000). The Multiple Cause of Death (MCD) files represent the single most source of information on reported deaths in the United States. Individual level data of all recorded deaths are collected from death certificates filed in State vital statistics offices and forwarded to NCHS for processing and distribution in NCHS Mortality Series reports and volumes, as well as, in public use files. The death certificate contains demographic information, such as age, race/ethnicity, sex, education attainment, marital status, occupation, usually provided by a family member, and cause of death information provided by the attending physician, medical examiner or coroner (Rosenberg et al, 1999). Information on infant deaths will be used in this application as the numerator to calculate the infant mortality rate (IMR).

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<u>Linked Birth/Infant Death (1995 to 2000)</u>. For more detailed analysis of SES impacts on infant mortality patterns we will employ the linked birth/infant death records spanning the period 1995 to 2005. The linked birth/infant death data files are special files created by NCHS which match each reported infant death to their birth record, providing valuable information for monitoring and exploring the complex interrelationships between infant death and risk factors present at birth, such as access to prenatal care, birth weight, maternal smoking and SES of the mother. Infant death information for Pacific Islanders were first tabulated and released in 1995 and for each subsequent year that followed.

<u>U.S. Census of Population (1990 and 2000).</u> An essential aspect of the proposed analysis will be the creation of denominator estimates for Pacific Islanders for the years 1990 to 2000. As no disaggregated intercensual estimates for the Pacific Islander population have been developed by Census or other federal authority, our population estimates are based upon existing work by the Principle Investigator funded by the NIH-National Center for Minority Health and Health Disparities.

Analysis Approach

<u>Intercensal Estimation of Resident Population.</u> Our intercensal estimates for the US resident NHPI population were derived using the standard estimation techniques employed by the Bureau of the Census and other federal and state organizations. Specifically, the "Components of Population Change Method" was applied to the estimated annual midyear resident population of Pacific Islanders using the Census 1990 enumeration as our baseline. The following formula was applied each year to update the population from the previous year:

$$\text{Pop}(i+1) = \text{Pop}(i) + \text{Births} - \text{Deaths} + \text{Net international migration} \quad (4)$$

This formula, also known as the Balancing Equations is defined as follows:

   1. The estimated resident NHOPI population for Year(i) and the specified subgroups
   2. + total annual births to the U.S. resident NHOPI women,
   3. – total annual deaths to the U.S. residents NHOPI population
   4. + net international migration

1. The estimated population in Year(i) is based upon the baseline 1990 enumerated resident population from the April 1, 1990 Decennial Census estimated forward annually to the expected population in year of interest.
2. Registered births to United States resident women are estimated from data supplied by the National Center for Health Statistics. The primary source for this birth data is extracted from the Natality Detail Files produced annually by the National Center for Health Statistics and archived at the Inter-university Consortium for Political and Social Research (ICPSR). The Natality Detail File is an administrative Census of all registered births in the United States with standardized information on the birth location, and the demographic characteristics and the infant and the mother.
3. Registered deaths to United States residents are also estimated from data supplied by the National Center for Health Statistics. The primary source for this birth data is extracted from the Multiple Cause of Death Detail Files produced annually by the National Center for Health Statistics and archived at the Inter-university Consortium for Political and Social Research (ICPSR). The Multiple Cause of Death File is an administrative Census of all registered deaths in the United States with standardized information on the location of death, and the demographic characteristics and the descendent.
4. The net international migration component for the intercensal estimates of NHPI population estimates represents a residual factor after all births and deaths are accounted for. This is done for a number of reasons, one being our lack of access to the detained immigration information available to the Bureau of the Census. Of equal importance, however is the political relationship between the majority of Pacific Islanders and the United States. Hawaiian and Guamanians are all US citizens at birth by definition and as their place of origin is part of the United States there is no international migration factor to reconcile. Similarly, American Samoans, while not US Citizens are US Nationals and have free access to the US without restriction as American Samoa is an unincorporated and unorganized territory of the United States, is administered by the U.S. Department of the Interior. Consequently, the only international migration factor that needs to be addressed is the small numbers of other Pacific Islander populations included in the broader NHOPI inter-censual estimates. These net inflows can be estimated using existing projection and estimate adjustment techniques.

Applications of Intercensal Estimates

Describing the infant mortality patterns of the Pacific Islander population in the United States.

E.2.1 Infant Mortality Rate. The infant mortality rate (IMR) represent the most commonly used index for measuring the risk of dying during the first year of life. While the basic research approach will remain the same, the small number of reported infant deaths among Pacific Islanders will limit the level of detail at which we can perform our analysis. Unlike our other death rates, infant mortality rates are calculated by dividing the number of infant deaths in a calendar year by the number of live births registered for the same period. Like other rates they are presented as rates per 1,000 live births but unlike the other measures they draw both their numerator and denominator from the same administrative universe. The denominator of total live births for the year of interest will be obtained from the NCHS Natality Detail files and provided by ICPSR. The formula used to calculate infant mortality rate:

$$IMR = D_o / B_o \times 1,000 \qquad (1)$$

where D_o equals deaths to infants (children under one year of age) in a given year and B_o equals births in the given year.

For the examination of specific cause of death, NCHS currently identifies 130 cause specific deaths for ICD-10 codes and prior to 1998 they identified 67 cause specific deaths for infants under the ICD-9 classifications. Lacking sufficient cell size to examine infant death at this level of detail we will use summary measures provided by NCHS to look at broad specific cause of death categories such as deaths resulting from causes such as certain conditions originating in the perinatal period (P00-P96), congenital malformations, deformations and chromosomal abnormalities (Q00-Q99), sudden infant death syndrome (R95) according to the Tenth Revision ICD cause-of-death codes.

Life Table Estimates. The life table is a basic demographic tool used to calculate the average remaining lifetime, or expectation of life. We will calculate period life tables that account for the combined mortality experience of people of all ages within a specific time period (normally a year). This type of life table assumes a hypothetical cohort that is subject to the age-specific death rates of the period of interest and represents a theoretical snap shot of what the mortality experience of the population would look like if observed death rates remained constant across the lifecourse (Shyrock & Siegel, 1971).

To generate our life tables for Pacific Islanders we will employ information on both the number of deaths at specific ages (D_x) and the estimated number of people alive at each specific age (P_x) (which are our age specific death rates) for males and females. This information provides us with our central death rate of m_x using the formula:

$$m_x = D_x / P_x \qquad (2)$$

this in turn allows us to calculate our base life table probability of death:

$$q_x = 2m_x / 2 + m_x. \qquad (3)$$

From q_x we will calculate the remaining life table functions l_x, ${}_nd_x$, ${}_nL_x$, T_x and e_x following established routines for the creation of single year and abridged (5-year) life tables (Shryock & Siegel, 1971). Using our analysis of death rates calculated from the mortality detail files and our intercensal estimates we will identify appropriate measures of q_x both “all cause” and our primary specific causes of death, diseases of heart (I00-I09, I11, I13, I20-I51) and malignant neoplasms (C00-C97) using the ICD Tenth Revision for Pacific Islanders in the US continent and Hawaii (DHHS, 2004). Separate life tables will be generated for Native Hawaiians, Guamanians and Samoans so we can measure and test differences in calculated survival curves, life expectancy and other indicators of heterogeneity between these groups.

Estimating Mid-year population for mortality analysis. The key calculation for all of the mortality indices will be to establish reasonable measures of our mid-year population (P_x) for the years of interest to our analysis. At present neither the Census Bureau nor NCHS provides intercensal estimates of Pacific Islander populations disaggregated from the traditional category of Asian/Pacific Islanders (APIs). As a result, the current intercensal population estimates are inadequate for the purpose of establishing central death rates for Pacific Islanders during the 1990 to 2000 interval. To overcome this limitation we will generate a series of intercensal population estimates for the US Pacific Island populations and subgroups between the 1990 and 2000 censuses. The fact that we have detailed census information for Pacific Islanders by age, sex and ethnicity for time periods that bound the years of our research interest (1990-2000) will greatly facilitate our ability to generate reasonable intercensal estimates.

Aim 2: To examine the association between socioeconomic status (SES) and infant health outcomes for Pacific Islanders and explore the role of SES in ethnic difference in infant health status among Native Hawaiians, Samoans and Guamanians.

Once we have estimated our population numerators, denominators and vital events for each year of interest we can generate comparative statistics for fertility, child mortality, health and the impacts of SES on these factors. As this information already exists or can be easily obtained for Whites, Blacks and Hispanics our NHPI results can be standardized so direct comparisons can be made for key health variables within the population and known levels of SES such as education, employment, income, poverty and household composition. These will all represent population level comparisons, but they will also represent key indicators needed to evaluate the health of NHPI children and the risks of morbidity and mortality across time.

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