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DETERMINANTS OF COMORBIDITY AT THE TIME OF DEATH IN FOUR ASIAN AMERICAN GROUPS

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ABSTRACT

DETERMINANTS OF COMORBIDITY AT THE TIME OF DEATH IN FOUR ASIAN AMERICAN GROUPS

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This study examined the intersection between morbidity and mortality in four Asian American populations, namely Japanese, Korean, Chinese, and Vietnamese Americans. It uses the total cause approach developed by Johnson and Christenson (1998) of summing the total causes of deaths mentioned in the death certificate as an indicator of comorbidity. Data were taken from the 1997 United States Multiple Cause of Death file produced by the NCHS. The results of the observed means analysis show that the effects of socio-demographic variables such as age, sex, education, marital status, and nativity are generally small. Larger differences in average level of comorbidity are found by race, residence in the West, and underlying cause of death (UC). The results of the multivariate analysis show different effects of these socio-demographic variables on the risk of having high comorbidity at the time of death. Unexpected results for Japanese, Chinese, and Korean Americans, and married persons are found and alternative explanations are discussed.

To Ina E. Muljono with love and gratitude

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BACKGROUND

Studies that examine demographic, socioeconomic, and other differentials in mortality and morbidity at the national level have typically in the past used either dichotomous (Black/White) or trichotomous (Black/White/Other) categorizations of race (See for example Manton 1980; Menchik 1993). As many of these studies use vital statistics or Census data for calculation of death rates, a partial explanation for such a narrow definition of race could be attributed to the lack of opportunity for the respondent to self-identify or choose an appropriate race category on these official forms. When the rare and sporadic opportunity does occur, it is often motivated by the contemporaneous political agenda and thus historically there was no systematic and consistent effort to collect these data. For example, the Census Bureau recorded groups like Chinese and Japanese Americans before the 1900s due to the large influx of immigrants during that time. In contrast, the 1960 U. S. census only used a Nonwhite/White dichotomy to measure race. Because this was before the 1965 Immigration Act, which opened doors to immigration, there was no motivation to count persons belonging to other racial or ethnic groups than the dichotomy. The 1970 census continued this restrictive collection of race data despite of the passage of the 1965 Immigration Act. The result is gross misclassification of race, as some large immigrant groups such as Asian Indians were added to the White population, while Vietnamese Americans were classified with the "all other races" category (U.S. Census Bureau 2002).

However, as the United States becomes more diverse in race, ethnicity, and nationality, after the 1965 Immigration Act, the importance of reporting detailed race categories was seen; it enabled the creation of health and mortality profiles of many previously uncounted minority groups. Moreover, these profiles could be used to enhance the delivery of health and other community services. Although it is important to examine many varieties of ethnic and race differentials, there are several reasons why the Asian American population is particularly interesting. The Asian American population numbered 11.9 million in 2000 (USCB 2002). This was almost a twofold increase from the 1990 Census, which itself was also a twofold increase from the 1980 Census (USCB 1993). The rapidly increasing rate of the Asian American population has led researchers to examine this population more closely to determine any existence of special health or mortality risks. Although Asian Americans consistently had the highest median household income and high educational attainment in the last decade, this group unexpectedly had higher poverty rates than non-Hispanic whites (NCHS 1998). Mortality research has demonstrated the negative consequences of poverty on health and mortality (Menchik 1993). Despite higher poverty rates, death rates among Asian Americans remain consistently lower than Whites. These facts call for mortality and morbidity examinations at a national level using detailed Asian categories to uncover any within-group differences.

This study will analyze determinants of comorbidity at death among Chinese, Japanese, Korean, and Vietnamese Americans at the national level using 1997 mortality data. This research uses the methodology developed by Johnson and Christenson (1998) of analyzing sociodemographic differentials in the total causes of death mentioned in death certificates of the decedents as a way of assessing the severity of comorbidity at death. Because this methodology has not been previously applied to Asian American mortality and morbidity research, the nature of this study is exploratory. The next section will discuss previous research on Asian Americans in general and the four groups respectively to guide the expectation and explanation of the findings.

General Asian American Mortality Research

Although the Asian American population is rapidly increasing, its proportion relative to the rest of the population is still somewhat small, composing 4.2 percent of the total population in 2000 (USCB 2002). Many reports and studies consequently either do not disaggregate the Asian American category by specific nationality or ethnicity or they do not include the Asian category at all. Out of the few studies that include a general Asian American category, a study by Rogers et al. (2000) offered insights on determinants of low mortality among adult Asian Americans. The authors used the National Health Interview Survey (NHIS) from 1989 to 1994 linked with the National Death Index (NDI) for 1989 to 1995. They found that Asian Americans have a 30 percent mortality advantage over Whites, controlling for age and sex. Although in subsequent models that controlled for nativity, length of US residence, education, income level, marital status, and employment status showed that Asian Americans still had a lower mortality risk compared to Whites, the 30 percent advantage was reduced to 20 percent.

Further analysis showed that this mortality advantage was not observed across three underlying causes of death. For example, the lower mortality risk among Asian Americans became statistically insignificant after controlling for all demographic and socioeconomic variables mentioned above for circulatory diseases, cancer, and residual causes other than "social pathologies." For social pathologies, which include accidents, homicides, and suicides, however, the authors found a greater and statistically significant mortality advantage among Asian Americans. There was a 50 percent lower risk of mortality from social pathologies among Asian Americans compared to whites. After controlling for demographic and socioeconomic factors, the mortality advantage increased slightly to 56 percent. This study also found mortality advantages among the foreign-born population, higher educated, and married persons.

Mentioned briefly in this study is the existence of an epidemiologic paradox among immigrants. The epidemiologic paradox essentially revolves around unexpectedly low mortality rates among underprivileged immigrants. This is surprising given the strong causal relationship between socioeconomic status and mortality. Some researchers attribute this low mortality to the health selectivity in migration while others believe that return migration leaves elderly persons statistically "immortal" (Abraido-Lanza et al. 1999). The healthy migrant effect means that the difficulty in the immigration selects individuals who are not only physically strong but resourceful as well. This is why some researchers believe that despite the low socioeconomic condition, immigrants have lower mortality. The "salmon bias" on the other hand draws attention to a possible technical issue in immigration research. If statistically uncontrolled, the possibility that frail elderly immigrants return to their home countries to die will lower the death rate of immigrants. Albeit that most work in this area involved Mexican immigrants, the relevance extends to Asian immigrants as well.

In sum, nativity, education, and marital status are important determinants in the mortality risk of Asian Americans. Examination of multiple cause-of-death data is needed because the mortality advantage of Asian Americans was only observed for particular causes. Competing explanations offered by previous researchers for the low mortality rate of immigrants, namely the healthy migrant effect and the salmon bias, need to be considered for the Asian American population as well.

Demographic and Socioeconomic Differentials in Four Asian American Groups

The main problem of using a broad Asian category in health and mortality research is that the category captures too numerous and diverse nationalities, ethnicities, and cultures that inferences to this population becomes somewhat ambiguous. The diversity found among Asian Americans demonstrates the pressing need to conduct mortality and morbidity analyses that are disaggregated by detailed Asian categories. On the other hand, this problem may also compel the researcher to select wisely the categorization of detailed Asian groups to retain continuity among the categories chosen and preserve the focus of the study. In this paper, I selected four Asian groups, namely Japanese, Chinese, Korean, and Vietnamese Americans. I have also included non-Hispanic Whites for comparative purposes. Although the data were also available for such large groups as Asian Indians and Filipino Americans, I pooled these groups into the "Other Asian/Pacific Islander (API)" category to preserve focus and continuity in the study.

There are several reasons for the selecting Japanese, Chinese, Korean, and Vietnamese American groups. One reason is the sizes of the respective groups. The four detailed Asian American groups comprised 56.6 percent of the total Asian and Pacific Islander (API) population in 1990. The largest among these groups were Chinese Americans with 23.8 percent, followed by Japanese Americans with 12.3 percent, then Korean Americans with 11.6 percent, and Vietnamese Americans with 8.9 percent (U.S. Census Bureau 1993). Another continuing factor among these groups is the similar cultural roots. All four groups share similar Confucian roots that some studies found significant in determining crucial elements in health and longevity such as intergenerational relations and elder care (Ishii-Kuntz 1997). A third continuing factor is similar settlement patterns. With the exception of New York City, 49 percent of the Asian American population lives in the West (USCB 2002). Furthermore, in nine metropolitan areas in California, the proportion of Asian Americans relative to the rest of the population ranged from 29 to 54 percent.

One study by King and Locke (1987) in particular examined the effect of residence in metropolitan areas that are heavily populated with Asian Americans, namely New York City and San Francisco, on the health of Chinese Americans. Using data from the New York City Health Department and the National Cancer Institute from 1969-71, the authors observed higher mortality levels in Chinatown areas than in the rest of the Chinese American population who did not reside in the Chinatowns in New York, California, and Hawaii. Further analysis showed twofold increases in mortality from tuberculosis, nephritis, and homicides among Chinese Americans who resided in Chinatown than their non-Chinatown counterparts. This study suggests that the environment of the Chinatowns examined was responsible for the detriment to the health of Chinese Americans. The quality of the physical environment in Chinatown was poor. Living in these contaminated areas heightened the risk of death from cancer as it relates to environmental quality and dietary practices. The working environment of Chinatown is also deprived. Many women who worked in the garment industries were exploited by their employers. The increased depression and stress from the abuse and long working hours heightened the suicide risk of female garment workers. The effect of Chinatown residence is thus important to be measured.

Since this study was published, however, many ethnic suburbs emerged alongside the rapid increase of the Asian American population. This is most evident in California where the Asian American population grew not only in the metropolitan areas of Los Angeles, San Diego, San Jose, and San Francisco, but also in their surrounding suburban areas. Similar to the suburbanization movement of Whites, this may mean that many Asian Americans take residence in the suburbs and work in Chinatown. Moreover, although Chinatown residence has been found to be detrimental to the health of Chinese Americans and thus emphasizes the need to examine the metropolitan residence of Asian Americans, recent developments suggest that other non-Chinatown places with high concentration of Asian Americans should be examined as well. Thus, as most of the Asian American population resides in the West, it is reasonable to use a West/non-West dichotomy.[1]

There are also well-known differences among the four groups. Some of these differences are directly related to health and mortality such as the nativity composition of the group, immigration status, immigration history, and demographic/socioeconomic statuses. These differences influence one another, as we shall see later in the paper. I will discuss trends and findings from previous research about each group in relation to the four differences and how they relate to health and mortality. These trends and findings will partially contribute to expected directions of relationships between various

[1] A separate analysis with a metropolitan/non-metropolitan residence variable proved the dichotomy to be inefficacious in predicting higher comorbidity. The national level of this study (and thus effectively including numerous metropolitan areas with low proportions of Asian Americans) is a possible cause for this finding.

demographic, socioeconomic, and cause-of-death variables and comorbidity at death in the multivariate analysis.

The first difference is the nativity composition of the four groups. According to the 1990 Census, the proportions of foreign-born persons are similar among Vietnamese (80 percent), Korean (73 percent), and Chinese Americans (69 percent) (USCB 1993). However, 68 percent of Japanese Americans are native-born. Many studies examine the relationship between various generations of Asian immigrants and their health and mortality (Gordon 1989; Ishii-Kuntz 1997; Le 1997; LeClere et al. 1994; LeClere et al. 1997; Montero 1981). First-generation adult immigrants have been found to be healthier than second and subsequent generations (Rumbaut 1999). Theorists believe that as younger generations assimilate to the broader American culture, they lose some of the healthy behaviors promoted by their native cultures and acquire unhealthy habits promoted by the host culture, particularly dietary practices (Fujimoto et al. 1996; King and Locke 1987; Rumbaut 1999). Other researchers find such groups as Japanese Americans that assimilate faster and in greater degrees had higher income levels and educational attainment (Montero 1980). Even children of recent immigrants who assimilate faster than their parents indicate high educational achievements (Caplan et al. 1992). These scholars thus see assimilation as beneficial. Yet a third perspective argues that there are segmented patterns of assimilation among recent immigrant groups, thus resulting in positive or negative outcomes depending on what part of the American culture immigrants assimilate into (Zhou 1997).

The second difference is found in the immigration history of these groups. Chinese and Japanese Americans have had a long migration history dating back to the mid-to-late 1800s, while immigration flows from South Korea and Vietnam occurred more recently after 1965 (Kuo 1998). The long migration history in the Japanese and Chinese American populations led them to have different experiences in the US. Japanese Americans, for example, experienced extreme racial discrimination and were placed in concentration camps during World War II. These experiences may have adversely affected the health of Japanese Americans today. Chinese Americans have also experienced extreme racial discrimination during the early part of their migration history.

The lives of early waves of Chinese immigrants were affected by the unbalanced sex structure of this group. Immigration policies made it extremely difficult for Chinese women to join their husbands in the US (Ishii-Kuntz 1997). Many of these men remained in the US and stayed single for the rest of their lives. The disruption of Chinese families caused by this migration history could also have adversely affected the health of Chinese American men (Ishii-Kuntz 1997). More recent waves of Chinese immigration occurred after the 1965 Immigration and Naturalization Act (Kuo 1998).

The other two groups, Korean and Vietnamese Americans, had shorter migration histories. Korean Americans tend to bring their spouses and elderly parents into the US as part of the 1965 Immigration and Naturalization Act. As the adult children work, elderly Korean American parents tend to stay at home. Many of these persons have language barriers and thus feel isolated from the rest of the community. Researchers found that mental health, especially depression, is especially a concern among this group (Kim and Grant 1997). Vietnamese immigrants began to enter the US in the late 1970s. This group is the only one among the four that primarily immigrated due to political turmoil in their home country.

Another result of these unique immigration experiences is a similar demographic composition in each immigrant group. The age structure of the Asian American population, for example, tends to be younger. Because age increase has been found to be concurrently related to higher mortality in the general population, the Asian American population may exhibit lower mortality. The sex ratio in these four groups favors men to women whereas the reversed trend is found in rest of the population. In relation to mortality, the general population tends to have a higher male mortality than female. In addition, Johnson and Christenson (1998) found that men tend to die with more comorbid conditions than women. Although there is an absence of previous research in this area for Asian Americans, the pattern found by mortality researchers on the general population may still be applicable to these four groups.

The third difference among the four groups is experience with refugee status. As mentioned earlier, Vietnamese Americans differ from the other three groups because they were mainly involuntary migrants. At first the wealthiest Vietnamese fled their home country to the United States. A few years later followed those with lower socioeconomic statuses. This second group of immigrants experienced greater trauma in their home countries. Some of them even spent time in refugee camps prior to entering the US. The journey into the US was difficult. Coming often by boat, many of the second wave immigrants from Vietnam became ill or even died along the way (Le 1997). Starting in 1985, a third wave of Vietnamese immigrants, consisting mainly of immediate family members of Vietnamese Americans, entered the US. Some researchers hypothesize that the socioeconomic and political conditions in the sending country along with the experience of displacement among Vietnamese Americans may have caused stress and other health-related problems (Oliver-Smith and Hansen 1982; Scudder and Colson 1982). Although the rough conditions suffered by survivors in the second wave of immigrants from Vietnam may also have brought the healthiest ones, the 'healthy migrant effect' does not apply to this population by virtue of its unique experience as a refugee population.

Observing the trends found in the Japanese, Chinese, Korean, and Vietnamese communities, the cumulative effect of immigration history and statuses as voluntary migrants or refugees leads also to socioeconomic differences. In 1990 Japanese Americans were the oldest group with the median age of 36.3, followed by Chinese Americans (32.1) and Korean Americans (29.1). Vietnamese Americans are the youngest with the median age of 25.2 years (USCB 1993). Educational attainment among adult men in 1990 also differed among these four groups, with 89.9 percent of Japanese Americans having had high school degrees, followed by Korean Americans (89.1 percent), Chinese Americans (77.2 percent), and Vietnamese Americans (68.5 percent). Per capita income levels in 1990 show a greater disparity among these groups. Japanese Americans had the highest with $19,373 and Vietnamese Americans had the lowest with $9,032. The lower income levels in the Vietnamese American community are reflected in their poverty rate, which is about 3.5 times the lowest group, Japanese Americans.

Socioeconomic differences are directly related to health and mortality. More disadvantaged groups like Vietnamese Americans will be more likely to have higher mortality and morbidity compared to Japanese Americans who have higher socioeconomic levels. Although the Korean and Chinese Americans have lower SES than Japanese Americans, the healthy migrant effect may be stronger than the socioeconomic forces that influence mortality. Vietnamese Americans, on the other hand, have a double disadvantage with low SES and refugee status.

In sum, mortality research on the broader Asian American group exposed mortality advantages in this group compared to whites. Yet examination of Korean, Vietnamese, Japanese, and Chinese Americans shows great diversity in the nativity composition of these populations, immigration statuses and histories, as well as demographic and socioeconomic characteristics. Because these differences directly relate to health and mortality, they call researchers to reconsider the findings from the general Asian American group and use detailed Asian categories wherever possible. General and national mortality research has greater advantage of generalizability than studies on specific Asian categories, which oftentimes use regional or local data. Nevertheless, both levels of studies find that certain demographic factors such as age, sex, region of residence, and nativity along with socioeconomic factors such as education and marital status are important determinants of mortality and morbidity (Rogers 1995; Rogers, et al 1996; Verbrugge and Jette 1994). Some studies also found mortality differentials among various causes of death (King and Locke 1987; Rogers, et. al 2000). This suggests that by incorporating a more complex view of mortality, researchers could examine the variety of ways that sociodemographic differentials affect mortality conditions and risks. In the next section I will discuss the approach taken by Johnson and Christenson (1998) in examining the intersection between mortality and morbidity by using the total causes mentioned in the death certificate.

The Total Cause Approach to Assessing Comorbidity at Death

General mortality researchers are moving towards multiple cause-of-death analyses because there is more to mortality differentials than the variety of underlying medical cause of mortality. Charles Nam (1990) points out,

> "More and more, we have come to realize that the complexity of mortality analysis is reflected in the fact that death is best viewed not just as a momentary vital event in time but also, and more meaningfully, as the end of a life-long process during which the individual has experienced some brief and some prolonged episodes of illness and disability which have combined with the person's genetic and physiological stock to alter the risk of survival" (p. 334).

One approach suggested by Nam and developed by Johnson and Christenson (1998) is to examine the magnitude of the total causes of deaths mentioned in the death certificate (TC) in addition to the underlying cause of death (UC). The National Center for Health Statistics (NCHS) (1997) defines UC as "(a) the disease or injury which initiated the train of events leading directly to death, or (b) the circumstances of the accident or violence which produced the fatal injury" (p. 3). UC is thus the primary cause of death while TC, according to Nam, captures both the diagnoses it triggers and "other significant conditions contributing to the death but not directly related to the [underlying cause]" (p. 334). Thus, more TCs mentioned imply higher degrees of comorbidity at the time of death.

Johnson and Christenson (1998) used 1989-91 death certificate data from Michigan to examine whether sociodemographic differentials in comorbidity at the time of death were real or artifactual. Utilizing an epidemiologic transition framework (Omran 1971), the authors found support for the hypothesis that age was more significantly related to variations in mean TC than other demographic factors such as race, sex, and education. They also found that various UCs have varying means of TC.[2] This is also consistent with the epidemiologic transition framework in that there will be greater comorbidities in chronic UCs than acute ones. For example, the authors found that persons dying from such diseases as diabetes and hypertension had higher mean TC than persons dying from social pathologies such as accidents, suicides, and homicides. Thus, older persons dying from chronic diseases have more comorbidity than others. In regards to race, Blacks died with more comorbid conditions than Whites. For unautopsied deaths, the difference is small for chronic diseases and larger (0.4 more cases for black females) for social pathologies.

The epidemiological transition framework may not apply well to a group with high proportion of immigrants such as Chinese, Korean, and Vietnamese Americans. Because members of these groups originated from countries currently on varying earlier stages of the epidemiologic transition, the immigration process disrupted the smooth epidemiologic transitions that they were supposed to experience had they remained in their home countries. Thus, the ordering of comorbid conditions from low to high according to the stages of epidemiologic transition may not be found in these populations.

One cautionary comment offered by Nam (1990) in regards to this approach of measuring comorbidity is the reliability of the TCs mentioned in the death certificate. Studies conducted by the National Center for Health Statistics (NCHS) found systematic variation among the recording of multiple causes of deaths by the certifier (Nam 1990). There may be more conditions discovered when autopsies are performed, for example, than when no autopsies are performed. The performance of autopsies thus increases

[2] Underlying medical causes and Total causes were coded according to the fifteen leading causes of deaths using the Ninth International Classification of Diseases (ICD-9).

greater accuracy in the count of TCs. Furthermore, the type of certifier also affects the accuracy of TCs. Johnson and Christenson (1998) pointed out that autopsies performed by private physicians for "nonlegal reasons (i.e., the scientific interest of the case or the request by other family members) are expected to yield the most thorough counts of all medical conditions that contributed to the death of an individual, as well as confirmation of the UC" (p. 264). Thus, Johnson and Christenson controlled for autopsy performance and the type of certifier and found a 1.35 difference in the mean TC performed by Medical Examiners and private physicians, with the latter group reporting higher mean TC than the earlier group. This strengthens the study's claim that sociodemographic differentials in comorbidity at death are real and not an artifact.

The national mortality data set, unfortunately, does not contain an item on autopsy status because it does not appear on the death certificate of every state. However, there are two procedures undertaken by the NCHS to ensure maximum accuracy of the national Multiple Cause of Death (MCD) file of these death certificates. First, let us look back to 1968 when the computerization of MCD data began. The NCHS instituted the use of a computer program called Automated Classification of Medical Entities (ACME). The data entry personnel first inputs all the causes of deaths listed on the death certificate into ACME, which then applies World Health Organization (WHO) rules in selecting one underlying cause of death. The system then creates two separate variables to store the rest of the causes mentioned in the death certificate: record and entity axes. The entity axis variable preserves all causes listed by the physician for multiple cause analyses. However, Charles Name (1990) points out that the record axis variable "involves an 'axis translation' of the original cause data to create a set of codes, which are free of contradictions among causes reported, devoid of repetitive codes, and the most precise within the ICD-9 classification structure and medical info on the record" (p. 334).

The ACME software was gradually replaced by fully automated MCD coding software called Medical Indexing, Class, and Race (MICAR). MICAR eliminated potential data entry errors by fully automating WHO rules for the selection of UC from the array of causes mentioned. In 1993, yet another software was implemented which improves upon MICAR's coding ability by allowing the actual written responses of the examiner to be entered into the computer. This software was appropriately named SuperMICAR. By 1995, twelve states used SuperMICAR, which processed about 75 percent of the death certificates in these states. The rest of the death certificates (74 percent) were coded using MICAR. Death certificates from 1997 were processed with SuperMICAR and MICAR at the same rates.

The second procedure taken by the NCHS to ensure maximum accuracy in the coding of MCD data involves continuous monthly sampling of eighty death certificates from states sending mortality records in electronic form (U.S. DHHS 1997). NCHS staff then code the original certificates in a separate file and compare them to the data obtained from the states. Depending on the discrepancies found between NCHS and state-coded data, the NCHS makes ongoing decisions for the need of corrective actions. For medical items on death certificates sent to the NCHS via non-electronic methods, NCHS staff recodes a 1 percent sample of the death certificates and check the results against the state-coded data.

RESEARCH QUESTIONS AND HYPOTHESES

Previous research found that socioeconomic factors influence health and mortality regardless of race, ethnicity, or nativity. Also, it is important to investigate the state of health at death because death, especially at older ages, results from an accumulation of diseases and disabilities. This area of research has not been extended to Asian Americans. The rapidly growing Asian American population is unique in that a large proportion is immigrants with health-related needs specific to this status. Thus, it is important to explore the following questions:

1. How do sociodemographic factors influence comorbidity at death in Chinese, Japanese, Korean, and Vietnamese populations?
2. How do these influences compare with Whites?

With the latest available mortality dataset and appropriate statistical methods, this study seeks to answer those questions.

Drawing on theories developed for mortality and health research on the general population as well as Asian Americans, the following hypotheses are formulated:

1. There will be small sociodemographic differentials in the average level of comorbidity, except for age and underlying cause of death (UC).
2. There will be different risks for having higher comorbidity for each sociodemographic factor.
    a. Older ages will *increase* one's risks for high comorbidity.
    b. Women will have *decreased* risks for high comorbidity.
    c. High educational level will *decrease* risks for high comorbidity.
    d. Marriage will *decrease* risks for high comorbidity.
    e. Foreign-born persons will have *decreased* risks for high comorbidity.

f. Residence in the West will *increase* risks for high comorbidity.

g. Korean, Chinese, and Japanese Americans will have *decreased* risks for high comorbidity.

h. Vietnamese Americans will have *increased* risks for high comorbidity.

i. Some UCs will *increase* the risk for high comorbidity while others will *decrease* this risk.

3. Sociodemographic factors will also operate differently within each group due to the uniqueness of each group resulting in varying risks for higher comorbidity.[3]

METHODOLOGY

Data Source

The data used in this study were taken from the Multiple Cause of Death file in 1997, a compilation of all death certificates issued in the United States within that year. All states in the United States submit these records to the National Center for Health Statistics, which then creates the MCD file and disseminates the data through the Interuniversity Consortium for Political and Social Research (ICPSR). Because this compilation consists of common elements in the US Standard Death Certificate, the socioeconomic variables included are quite limited. Important information such as performance of autopsies, which serves as a possible control for the accuracy of the total mentioned causes of death (Johnson and Christenson 1998), may be required by some states and not others and thus is not included in the national dataset.

When data are compiled from the whole population, the number of cases becomes extremely large and several problems may arise. One problem often found in population

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[3] This hypothesis is exploratory, given that previous research is absent. The results will open doors for future researchers to investigate deeper within each ethnic group.

datasets is missing data. Many times researchers resort to imputation to avoid problems with missing data. The variables used in this study, however, are generally complete with minimal imputations. Nevertheless, multivariate combinations of missing data could occur and thus increase the number of cases excluded in statistical analyses. Therefore, "unknown" categories in several socioeconomic variables are included to minimize missing data. The issue of missing data along with other exclusions made in this study will be discussed in detail as appropriate for the respective variables.

Another problem usually found in studies addressing particular ethnic minority groups is the small sample size. Although this study included the entire population, the number of deaths found in the Asian American population are miniscule compared to other ethnic groups. For example, the fewest adult deaths is found in the Vietnamese population with 1,308 in 1997. Nevertheless, this magnitude proves sufficient for the analyses performed in this study, even with the use of multiple-category independent variables such as underlying cause of death.

Dependent Variable

The dependent variable is the total number of causes mentioned in the death certificate (TC). It does not discriminate between specific values of the causes of death mentioned. The values ranged from 1 to 14 causes, with a total average of 2.69 TCs (see Table One). This variable was not normally distributed, with 75.2 percent of the cases having 1 to 3 TCs and the rest having 4 or more. The assumption that TC was normally distributed around the mean is violated and thus the properties of the central limit theorem are not valid (Agresti and Finlay 1997). Because of this, the multivariate analysis will use a dichotomized version of TC chosen at the natural break in the distribution, namely 4 TCs. This departs from Johnson and Christensen's study (1998) which used a continuous measure of TC.

Independent Variables

The independent variables are divided into three types: demographic, socioeconomic, and cause of death. The first type of variables is demographic. They include sex, age, nativity, region of residence, and the test variable race. The data on sex, recorded as male and female, contained no missing values and the two groups are proportionate to each other. There is a higher proportion of men to women in the four Asian groups, while the reversed is true for Whites (see Table 2).

Missing data are also not found in the age variable. Nevertheless, following the convention of Johnson and Christenson (1998), this study is restricted to adults 25 years and older. Korean and Vietnamese decedents are on average younger by 6 to 10 years than the others.

Although the dataset recorded nativity by US State in addition to several countries such as Mexico and Canada, this variable has been recoded into a trichotomy of native-born, foreign-born, and unknown nativity. Although the problem of missing data is not serious (ranging from 0.1 to 0.5 percent missing across the various racial categories), unknown nativity is included as a separate category to maximize the number of cases included in the analysis. Most Chinese, Korean, and Vietnamese Americans are foreign-born while most Japanese Americans and Whites are native-born.

There are several issues involved with the definition and selection of racial and ethnic groups of interest. One is missing values, which was slightly problematic in the race variable. Although the numbers of missing values themselves are not large, NCHS imputed the racial categories of 1,377 Whites, 34 Chinese Americans, 2 Japanese and Korean Americans respectively, 1 Vietnamese American, and 20 Other Asian and Pacific Islanders. The problematic aspect of the imputation of these values arises because the NCHS provided no information on its accuracy. As race is an important focus in this study, the aforementioned cases with imputed racial categories were excluded from the study. Another issue is the selection of persons with certain racial backgrounds. Consistent with its focus, this study excluded persons with racial backgrounds other than Asian American such as African and Native American. Nevertheless, Whites, which comprise over 80 percent of all deaths, were included to serve as the comparative group. Persons with Hispanic origin were also excluded from this study. The death certificate reports Hispanic origin separately from race because persons with Hispanic origin could technically be of any race. Because they lie at the intersection of race, ethnicity, and even nationality, there may be cultural and social complexities involved that are beyond the scope of this study. Thus, the exclusion of persons with Hispanic origin focuses the study to a more homogenous population.

Finally, as mentioned earlier, the Asian American category is divided into Japanese, Chinese, Korean, Vietnamese, and other Asian or Pacific Islander. The final population sizes are quite uneven: Whites with 1,860,939; Chinese Americans with 6,904; Japanese Americans with 5,005; Korean Americans with 1,796; Vietnamese Americans with 1,308; and Other API with 11,841.

The second type of independent variables is socioeconomic. The dataset contained few socioeconomic variables. A measurement of assets, which was not included in the dataset, is of course the most direct assessment of socioeconomic status.

Usually the accumulation of assets occurs over a lifetime and is associated with occupational status. Although occupational status is an important socioeconomic status indicator and included in the dataset, its use in the analysis of mortality becomes plagued with potential problems. The first and most significant problem is that occupational status is not recorded by all states. Second, many people are already in retirement when they die at older ages. This decreases the chance of ascertaining the person's occupation before they reach retirement. Third, occupational status is not constant over a lifetime. Some people ascend or descend the occupational ladder and others earn no wages for their work as homemakers. From these reasons, occupational status was not included as a predictor variable.

An indirect yet strong assessment of earnings and social status is education. Education's strength in predicting socioeconomic status is that it is tied to other socioeconomic variables. For example, many occupations require certain skills attained through higher education, thus without education higher occupational status may be unattainable. Secondly, educational levels tend to stay constant over a lifetime for adults aged 25 and older. After the initial compulsory education and perhaps postsecondary education, most people never return to obtain a higher degree. Thus, education is arguably the strongest and most stable indicator of a person's socioeconomic status. In this study, education is coded as primary, secondary, postsecondary, and unknown. Persons with unknown educational levels are included in the analysis to minimize missing data (total missing is 7.29 percent). The average education level of each group is similar, ranging from 10.4 to 11.6 years.

A social support variable included in the study is marital status. Studies have found marital status important in assessing one's health and longevity (Rogers et. al. 2000). Marriage, in particular, is associated with better health and longer lives among Americans (Rogers et. al. 2000). To capture the benefits of marriage as well as the complexity of marital status, this variable was coded into never-married single, married, widowed, divorced, and unknown. Missing data are not problematic for this variable, as the total percentage missing is 0.28 percent. Nevertheless, it has been included as a separate category to enhance the analysis. Across all groups, the proportion married is highest followed by proportion widowed.

The third type of independent variable is underlying cause of death (UC). Following the convention of Johnson and Christenson (1998), UC is divided into sixteen categories using the ninth revision of the International Classification of Diseases. Although this categorization indicated the leading causes of death in 1990, it is still highly significant in 1997. The categories are: diabetes, hypertension, septicemia, chronic obstructive pulmonary disease, nephritic diseases, pneumonia and influenza, heart disease, cerebrovascular disease, chronic liver disease and cirrhosis, atherosclerosis, HIV, malignant neoplasm, accident, suicide, homicide, and residual causes. There were no missing data in this variable.

Statistical Analysis

The methodology chosen for this study is somewhat unusual, as it only analyzes only the numerator of the more conventional mortality rate. Because of the detailed study population and combination of independent variables, it was impossible to compute mortality rates. Although the numerator exists, the Census Bureau does not publish denominators containing counts of the living population to such a fine detail. Nevertheless, a numerator analysis answers an entirely different and important question of the quality of near-death life. Furthermore, it is also a largely unexplored topic in the demography literature.

The analysis is divided into three sections. First, a means analysis was conducted to test the first hypothesis that there will be small sociodemographic differentials in the average level of comorbidity, except for age and underlying cause of death (UC). Second, two logistic regression models were constructed to test the second hypothesis that there will be different risks for having higher comorbidity for each sociodemographic factor. The first model incorporates demographic, social support, and socioeconomic variables. The second model adds UC to model one. Third, model two of the previous analysis is separately reanalyzed for Whites, Chinese and Japanese Americans, and Other API.

High comorbidity is defined as 4 or more TCs on the decedent's death certificate and low as having 1 to 3 TCs. These multivariate analyses will determine the odds of having higher comorbidity in comparison to the reference group within each independent variable while controlling for the other independent variables. The value 1.0 indicates equal odds as the reference group for having high comorbidity. Odds lower than 1.0 indicates less risk for high comorbidity. Conversely, odds higher than 1.0 indicates more risk for high comorbidity.

Tests for statistical significance are not strictly applicable, as this study contains the universe of the selected Asian American decedent groups. A study that samples a section of the universe needs to rely on tests of statistical significance to determine whether or not its findings are due to chance. The present study, however, does not need to rely on such tests because the study population contains a universe which, unlike a sample, does not have a sampling error. Thus, all observed findings from this study reflect the true characteristics of the universe, regardless of the results of the tests of statistical significance. However, tests of statistical significance will be presented with the sole purpose to indicate which independent variables are more salient than others in predicting higher comorbidity.

FINDINGS

Means Analysis

Table 3 presents the observed mean TC for the independent variables by race. The total mean of cause-of-death items in the death certificate is 2.69. This is slightly higher than the total TC mean observed by Johnson and Christenson (1998). Because the increase is small (0.21 cause) it could have been a result of better recording of TCs or the effect of the national level of the analysis which included states with lower overall SES and poorer health care infrastructure than Michigan.

There is a greater variability of mean TCs across all racial groups. Whites exhibited the lowest (2.68). The mean TCs for Chinese, Vietnamese, and Korean Americans were higher than whites. For Vietnamese Americans, this was expected given the immigration status of this group. Korean and Chinese Americans, however, were expected to have lower TCs because they would have carried the healthy migrant effect. Instead, the data reflect otherwise. The highest mean TC is observed in the Japanese population, with 3 mean TCs per decedent. This indicates greater observed morbidity at the time of death in this population. This is contrary to expectation because Japanese

Americans have the highest socioeconomic statuses compared to the rest of the groups, even to whites.

The mean TC for both sexes is very similar. It was expected that the difference be smaller than for age and UC. Region produced a significant mean TC differential among other independent variables. Those who reside in the West tend to have higher mean TCs than those who do not. For Asian Americans, this was expected given the findings of previous research that mortality rates among residents of ethnic communities are higher than residents of non-ethnic communities. Whites who reside in the West are likely to be dispersed and not as concentrated as Asian Americans. Thus, the mean TC differential for Whites in terms of residence in the West is only half to a quarter the differential of other groups. The nativity differential produced the expected foreign-born advantage over native-born, indicating a healthy migrant effect. Nevertheless, the differential is miniscule and warrants further analysis.

The differences in marital status mean TC are very small, reflecting slight disadvantage for widowed persons over all other categories. Albeit modest, widowed Vietnamese Americans exhibited the second largest differential in mean TC to Japanese Americans with "unknown" marital statuses. Never-married singles had the lowest mean TC of 2.7 while widowed decedents had a mean of 3.1 TCs. Education level produced a greater differential in mean TC. There is a clear gradient in the mean TC of all the groups with advantage for decedents with postsecondary education.

UC produced the greatest differentials in mean TC. Some diseases such as diabetes are clearly associated with higher mean TC. This is consistent with the findings in Johnson and Christenson (1998). However, mean TCs for acute diseases and social pathologies were not as low as the authors found. Homicides, for example had the lowest mean TC in their study while in this study persons who died from homicides had one of the highest mean TCs. Another difference is the range of mean TCs for the various UCs. The mean TCs observed in this study among whites ranged from 2.18 to 3.46. The range observed by Johnson and Christensen (1998) is much greater, starting from 1.1 to 3.6.

In sum, examination of observed mean TCs shows only slight differentials among all categories of the independent variables. Although the average TC is 2.69, since TCs ranged from 1 to 14, there are some individuals who died with extremely comorbid conditions. This leads the analysis away from the examination of means to ask a more complicated question, what are the determinants of comorbidity at the time of death? For this, I conducted logistic regressions predicting the odds of dying with 4 or more TCs, indicating a morbidity condition higher than the average deceased population.

Multivariate Analyses

Table 4 shows the odds ratios from the logistic regression predicting the odds of having 4 or more TCs in the death certificate. Model 1 controlled for all the demographic and socioeconomic variables while Model 2 added UC to the first model. Age was found to be statistically significant and had the effect of increasing the odds of higher comorbidity in older ages. This is consistent with the findings of Johnson and Christenson (1998) and the hypothesized direction. However, the influence of age on greater comorbidity in this study was very small, only 0.8 percent. Women had a slight advantage over men. Their odds of having greater comorbidity is 5 percent less than men. This advantage was slightly reduced with the introduction of UCs. Albeit small, this finding is consistent with the hypothesized direction. Foreign-born persons also had an advantage over native-born persons. The odds of dying with greater comorbidity was 9 percent less than native-born persons. The healthy migrant hypothesis cannot be rejected by this finding.

Decedents from the West had a 24 percent increased risk for higher comorbidity. This partly confirms the hypothesized relationship. Because race is controlled, the residential concentration in ethnic communities associated with Asian Americans should have been accounted for. This means that residing in the West is detrimental to one's health net of the independent variables. It would be interesting to examine whether the advantage is equal among all racial groups.

Out of the various race categories, only Vietnamese Americans and other API were statistically significant. Vietnamese Americans had 36.1 percent higher odds of greater comorbidity at death than whites. This group was expected to have higher odds due to the experience of displaced involuntary immigration.

Korean American decedents had 21.5 percent higher odds of dying from 4 or more TCs than whites. This was unexpected because Korean Americans have higher SES and as a group is largely composed of labor migrants. The healthy migrant effect did not operate for this group. Previous studies documented the high number of elderly Korean parents who joined their children through the Family Reunification Act. As mentioned earlier, many studies also found high incidence of depression and loneliness among these elderly parents due to isolation and inability to assimilate to the broader society because of communication difficulties. Perhaps these factors allow the accumulation of diseases among elderly Korean Americans to go unnoticed and result in elevated risks for high comorbidity.

The third highest group is Japanese Americans with 20.9 percent increased odds for high comorbidity compared to whites. Although Japanese Americans are not an immigrant group (and thus the foreign-born advantage does not apply to them), this finding is still unexpected. This is because Japanese Americans have higher SES even among whites and so at least their risk should have been the same as whites. Perhaps high SES in the Japanese American population operates against them. As Johnson and Christenson (1998) noted, lower quality health care could have the unintended effect of lower TCs recorded in the death certificate. This is because the physician responsible may not be familiar with the medical history of the decedent. Thus he or she may overlook certain conditions that are not apparent. Conversely, decedents with high SES could afford better quality health care. The unintended consequence of this, on the other hand, is a greater number of TCs recorded by the physician familiar with the patient's entire medical history.

Chinese Americans had an 18 percent greater risk than whites from dying with 4 or more comorbid conditions. This finding is also unexpected given the healthy migrant selectivity that should have protected them from these comorbid conditions. Previous research reported several findings that could partly explain this unexpected finding. One is the Chinatown settlement of this population. Although the analysis controlled for Western residence, perhaps in the case of Chinese Americans this is not specific enough. A separate analysis with only Chinese Americans would clarify this matter. Another explanation is the medicinal practices among elderly Chinese Americans. The use of traditional medicines that may alleviate but not cure diseases may allow the diseases to progress to a more advance stage. Furthermore, the reliance on traditional Chinese medicines may leave the hospital as a final resort. Thus, diseases may have accumulated and progressed before being treated by hospital physicians. A third explanation supports and has the same affect as the second one, namely the reported underuse of health care facilities by elderly Asian Americans. Further research needs to be done to identify the mechanisms that leave Chinese Americans at a greater risk for high comorbidity.

Education level shows a gradient with the advantage for higher-educated decedents. The odds for dying with 4 or more TCs for primary-school educated decedents were 17.8 percent higher than post-secondary educated decedents. This gradient confirms the hypothesis that higher education decreases the risk for high comorbidity.

Marital status showed advantage for currently married decedents. While the actual observed means showed advantage for divorced decedents in some racial groups, controlling for other demographic variables and education gave the advantage for married decedents, as expected. Never-married singles had the highest odds of dying with 4 or more TCs than the other groups compared to married decedents. It is important to note that the marital advantage here is very small. Furthermore, after the addition of UCs, the marital advantage disappeared altogether. This suggests that the marital advantage is associated with lowered risk for certain diseases. Perhaps diseases that are related to unhealthy lifestyles such as chronic liver disease, diabetes, and heart disease are the most positively affected by marriage. Further research needs to be done to identify the specific diseases that marriage alleviates the most.

In Model 2, the fifteen leading causes of deaths were compared to the residual causes category. Almost all of them were statistically significant, with the exception of hypertension and homicide. Another pattern is that almost all UCs are associated with lower odds than the residual causes except for diabetes, chronic liver disease and cirrhosis, and accidents. Persons dying from diabetes had a 72.2 percent higher odds of having 4 or more TCs at the time of death than persons dying from residual causes. The odds for those with chronic liver disease and cirrhosis was only slightly higher, with 6.8 percent. The odds for decedents from accidents was 62.8 percent higher as compared to those dying from residual causes. The lowest odds for greater morbidity is found among decedents from cancer. Compared to those dying from residual causes, decedents from cancer have a 57.2 percent lower odds from dying with 4 or more TCs.

These findings did not show any particular patterns, especially one that relates to the epidemiologic transition framework. As the study population experienced differing stages of the transition, perhaps an earlier stage in their home country and a more advanced stage in the U. S., it may not apply to them particularly. Another possible explanation is the technological advances in emergency and end-of-life care. These advances may save or allow persons dying from accidental causes to live a little longer than a decade ago. During this short duration, the person dying from the ultimately fatal accident could develop various complications. Since he or she is most likely under close medical attention, all complications are also likely to be detected by the physician. Thus, more TCs would be recorded in the death certificate. Data on the length of last hospitalization prior to death may help researchers unravel this issue.

In sum, many of the sociodemographic variables only slightly influence one's odds of dying with 4 or more TCs. Race, however, was an exception. The odds that Japanese Americans would die from at least four medical causes were 20.9 percent higher than for Whites; Korean Americans, 21.5 percent; Vietnamese Americans, 36.1 percent. Although one would expect higher odds among Vietnamese American decedents, Japanese Americans also had unexpectedly higher odds of dying from 4 or more TCs. Furthermore, these odds were increased when UC was added to the model. Race was almost as strong in predicting this negative condition as UC. This suggests that comorbidity is more closely related to causes of deaths than other socioeconomic and demographic variables. Furthermore, there are different relationships between causes of deaths and comorbidity. Some causes of deaths are associated with lower odds of dying from 4 or more TCs while other had greatly higher odds than the residual category.

The interpretation of some of the findings in the previously discussed analyses could benefit from further analysis into each racial group. Table 5 displays the results of logistic regressions on the odds for having 4 or more TC on the death certificate for Whites, Chinese and Japanese Americans, and Other API.[4] Although the purpose of this final analysis was to clarify the findings of the previous analyses, the earlier produced many intriguing results whose interpretations are beyond the scope of this study and may instead be a task for future researchers. This analysis is intended purely for exploratory purposes.

The analysis of region of residence shows that Chinese and Japanese Americans benefit more than Whites from not residing in the Western part of the United States. This would support the explanation given earlier that the residential concentration of these Asian American groups in the West increases their risk for dying with higher comorbidity. Perhaps residence in the non-West allows for positive assimilation of Asian

[4] Separate regressions for Vietnamese and Korean Americans were also conducted. Due to the small respective population sizes of these groups, some of the cells became empty. Thus, the models did not converge and the results are highly unstable.

Americans into the broader culture. This explanation is also supported in the loss of the foreign-born advantage in the Chinese American population net of the independent variables. For the Chinese American group then, assimilation is more beneficial. Nevertheless, future researchers should use more precise categories of Chinatown and other areas with high Asian American concentration. Furthermore, these findings do not explain why the non-West advantage for Whites remained. Perhaps the reverse is true for Whites, that residential assimilation heightens their comorbidity risk.

Other findings for the Chinese American population present another puzzling picture. While UC offsets the marriage advantage for Whites and Japanese Americans, the risk for high comorbidity among widowed Chinese Americans remained slightly higher. In opposition to this, divorced Chinese Americans have a 28 percent decreased risk for high comorbidity. Although divorced Whites and Japanese Americans also have lowered risk for high comorbidity after controlling for UC, the risk exhibited in the Chinese American population is 13 to 18 percent lower than the two others. A task for future researchers is to examine divorce in the Chinese American culture to uncover whether men and women derive the same health benefits from divorce and why divorce decreases high comorbidity risks in this population more than others.

Summary and Conclusion

The results of this study revealed differentials in sociodemographic characteristics, means of total causes, and determinants of comorbidity within and between Korean, Chinese, Vietnamese, and Japanese Americans. These observed differentials truly reflect the characteristics of the population, as statistical analyses were conducted on all U.S. deaths in 1997. Multivariate analysis revealed that Vietnamese

Americans and Other API had the greatest comorbidity at the time of death, after controlling for various sociodemographic factors, as well as for the underlying cause of death. The advantage of analyzing the entire universe is reflected in the higher odds of comorbidity found in the Chinese, Japanese, and Korean Americans groups compared to whites. Although these findings did not have $p<0.05$, they truly existed in the population and were not due to chance. This means that there are other unobserved factors within each group that increase their odds of dying with a higher level of comorbidity than whites.

The findings regarding Vietnamese Americans support previous research on the negative impact of political trauma and low socioeconomic status for this refugee-immigrant group (Gordon 1989; Le 1997).

The findings on Japanese Americans were more puzzling. Discrimination during the World War II era that exclusively targeted Japanese Americans likely had negative mental and physical health consequences (Jensen 1999). More research needs to be conducted to measure the magnitude of impact of these experiences on morbidity, especially at the older ages. The findings of this study also invite research on the intersection of morbidity and mortality for other Asian American groups such as Asian Indians and Filipino Americans. These groups have different religious backgrounds—Indians are mainly Hindu and Filipinos mainly Catholic--than the four examined in this paper. They also have different migration statuses and histories. The results of research on these populations will bring more insight on the diversity within the broad label, "Asian American."

There are several advantages to this study. First, it used the latest available US mortality data from 1997, thus improving and expanding the scope of current mortality and health literature for detailed Asian American groups. Second, this study improved upon general Asian American studies by using four detailed Asian categories, namely Japanese, Chinese, Korean, and Vietnamese Americans. Third, it used a unique approach to the examination of comorbidity at the time of death by using the magnitude of total causes mentioned in the death certificate, as developed by Johnson and Christensen (1998). This approach has not been explored by other Asian American health and mortality researchers.

There were also several limitations to the study. First is the accuracy of TC. In spite of technological advancements in the recording of multiple cause of death data, accuracy of the total causes mentioned may still be in question. Johnson and Christenson (1998) overcame this issue by controlling for autopsy status and the type of physician performing the autopsy. Nevertheless, these variables were unavailable in the national mortality dataset. Because autopsy status is recommended on the US Standard Death Certificate, I call for its inclusion in the national mortality dataset. Until this becomes available, future research needs to incorporate an indirect measure for autopsy status to ensure maximum accuracy of TC or conduct their analyses at the state level.

The second shortcoming to this study is the limited number of variables available in the mortality dataset. Since the populations of interest were largely immigrant groups, variables for immigration history and status would have contributed to the study. To improve the assessment of comorbidity, variables such as type of health insurance, medical history, behavioral health risks, and disability status would be important in future research. The third limitation to the study is the cross-sectional aspect of the data. I only used national mortality data from 1997 and in so doing I could not assess trends in sociodemographic differentials in mortality and comorbidity in Asian American groups. Future research overcoming these limitations will lead to a better understanding of differentials in comorbidity at the time of death.

Table 1. Distribution of Total Cause (TC)

Variables	White		Chinese		Japanese		Korean		Vietnamese		Other API		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
TC														
1 to 3	1,401,497	75.31	4,916	71.21	3,390	67.73	1,286	71.60	901	68.88	8,227	69.48	1,420,217	75.23
4+	459,442	24.69	1,988	28.79	1,615	32.27	510	28.40	407	31.12	3,614	30.52	467,576	24.77
1	433,444	23.292	1,135	16.440	872	17.423	304	16.927	211	16.131	2,138	18.056	438,104	23.207
2	530,643	28.515	2,047	29.649	1,333	26.633	558	31.069	355	27.141	3,246	27.413	538,182	28.509
3	437,410	23.505	1,734	25.116	1,185	23.676	424	23.608	335	25.612	2,843	24.010	443,931	23.516
4	254,655	13.684	1,084	15.701	789	15.764	281	15.646	215	16.437	1,947	16.443	258,971	13.718
5	119,814	6.438	510	7.387	457	9.131	144	8.018	115	8.792	960	8.107	122,000	6.463
6	50,905	2.735	234	3.389	212	4.236	49	2.728	41	3.135	446	3.767	51,887	2.749
7	20,678	1.111	114	1.651	93	1.858	19	1.058	20	1.529	175	1.478	21,099	1.118
8	8,129	0.437	28	0.406	35	0.699	10	0.557	10	0.765	46	0.388	8,258	0.437
9	3,151	0.169	14	0.203	17	0.340	5	0.278	3	0.229	27	0.228	3,217	0.170
10	1,333	0.072	2	0.029	9	0.180	1	0.056	1	0.076	8	0.068	1,354	0.072
11	480	0.026	1	0.014	1	0.020	0	0.000	2	0.153	4	0.034	488	0.026
12	190	0.010	1	0.014	2	0.040	1	0.056	0	0.000	1	0.008	195	0.010
13	85	0.005	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	85	0.005
14	22	0.001	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	22	0.001
Total	1,860,939	100.00	6,904	100.00	5,005	100.00	1,796	100.00	1,308	100.00	11,841	100.00	1,887,793	100.00

Source: U. S. Dept. of Health and Human Services, National Center for Health Statistics. Multiple Cause of Death 1997.

Table 2. Distribution of Independent Variables by Race

Variables	White		Chinese		Japanese		Korean		Vietnamese		Other API		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Mean Age (In Years)	*75.9*		*73.6*		*75.7*		*67.9*		*65.2*		*67.5*		*75.2*	
Region														
West	331,795	17.83	4,371	63.31	4,559	91.09	1,245	69.32	1,016	77.68	6,896	58.24	1,537,911	81.47
Non-West	1,529,144	82.17	2,533	36.69	446	8.91	551	30.68	292	22.32	4,945	41.76	349,882	18.53
Sex														
Male	906,947	48.74	3,775	54.68	2,516	50.27	936	52.12	700	53.52	6,868	58.00	921,742	48.83
Female	953,992	51.26	3,129	45.32	2,489	49.73	860	47.88	608	46.48	4,973	42.00	966,051	51.17
Marital Status														
Never-married single	140,552	7.55	340	4.92	470	9.39	62	3.45	119	9.10	828	6.99	142,371	7.54
Married	791,113	42.51	3,878	56.17	2,525	50.45	1,014	56.46	717	54.82	7,067	59.68	806,314	42.71
Widowed	746,065	40.09	2,411	34.92	1,681	33.59	601	33.46	394	30.12	3,230	27.28	754,382	39.96
Divorced	144,947	7.79	259	3.75	323	6.45	111	6.18	75	5.73	674	5.69	179,389	9.50
Unknown	5,262	0.28	16	0.23	6	0.12	8	0.45	3	0.23	42	0.35	5,337	0.28
Nativity														
Native-born	1,731,195	93.03	873	12.64	3,605	72.03	92	5.12	3	0.23	901	7.61	1,736,669	91.99
Foreign-born	120,840	6.49	6,013	87.09	1,393	27.83	1,701	94.71	1,304	99.69	10,866	91.77	142,137	7.53
Unknown	8,904	0.48	18	0.26	7	0.14	3	0.17	1	0.08	54	0.46	8,987	0.48
Education Level														
Mean (In Years)	*11.6*		*10.9*		*11.5*		*11.6*		*10.4*		*10.6*		*11.6*	
Primary	345,827	18.58	1,980	28.68	1,047	20.92	411	22.88	393	30.05	3,158	26.67	352,816	18.69
Secondary	929,136	49.93	2,680	38.82	2,469	49.33	681	37.92	597	45.64	3,656	30.88	939,219	49.75
Postsecondary	450,024	24.18	1,950	28.24	1,314	26.25	624	34.74	271	20.72	4,003	33.81	458,186	24.27
Unknown	135,952	7.31	294	4.26	175	3.50	80	4.45	47	3.59	1,024	8.65	137,572	7.29
Total	1,860,939		6,904.00		5,005		1,796		1,308		11,841		1,887,793	

Source: U. S. Dept. of Health and Human Services, National Center for Health Statistics. Multiple Cause of Death 1997.

(Continued)

(Table 2, Continued)

Variables	White		Chinese		Japanese		Korean		Vietnamese		Other API		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Underlying Cause														
Diabetes	45,261	2.43	211	3.06	150	3.00	71	3.95	37	2.83	439	3.71	46,169	2.45
Hypertension	9,804	0.53	62	0.90	28	0.56	13	0.72	11	0.84	77	0.65	9,995	0.53
Septicemia	16,785	0.90	41	0.59	41	0.82	5	0.28	7	0.54	107	0.90	16,986	0.90
COPD	98,084	5.27	273	3.95	144	2.88	49	2.73	54	4.13	395	3.34	98,999	5.24
Nephritis etc.	19,675	1.06	73	1.06	31	0.62	11	0.61	14	1.07	142	1.20	19,946	1.06
Pneumonia and flu	73,277	3.94	370	5.36	238	4.76	72	4.01	65	4.97	461	3.89	74,483	3.95
Heart disease	614,275	33.01	1,858	26.91	1,400	27.97	409	22.77	274	20.95	3,510	29.64	621,726	32.93
Cerebrovascular	132,708	7.13	687	9.95	521	10.41	171	9.52	138	10.55	1,153	9.74	135,378	7.17
Chronic liver etc.	18,885	1.01	39	0.56	37	0.74	27	1.50	13	0.99	114	0.96	19,115	1.01
Atherosclerosis	14,335	0.77	16	0.23	23	0.46	5	0.28	6	0.46	34	0.29	14,419	0.76
HIV	5,481	0.29	14	0.20	5	0.10	4	0.22	5	0.38	50	0.42	5,559	0.29
Cancer	447,954	24.07	2,070	29.98	1,387	27.71	583	32.46	385	29.43	2,867	24.21	455,246	24.12
Accident	58,914	3.17	251	3.64	144	2.88	111	6.18	81	6.19	590	4.98	60,091	3.18
Suicide	22,568	1.21	111	1.61	58	1.16	61	3.40	38	2.91	197	1.66	23,033	1.22
Homicide	5,063	0.27	48	0.70	7	0.14	17	0.95	16	1.22	158	1.33	5,309	0.28
Residual causes	277,870	14.93	780	11.30	791	15.80	187	10.41	164	12.54	1,547	13.06	281,339	14.90
Total	1,860,939		6,904.00		5,005		1,796		1,308		11,841		1,887,793	

Source: U. S. Dept. of Health and Human Services, National Center for Health Statistics. Multiple Cause of Death 1997.

Table 3. Observed Mean TC for Independent Variables by Race

Variables	White	Chinese	Japanese	Korean	Vietnamese	Other
Overall	2.68	2.88	3.00	2.85	2.97	2.91
Sex						
Female	2.68	2.86	2.98	2.85	3.03	2.86
Male	2.68	2.91	3.02	2.85	2.92	2.93
Education Level						
Primary	2.77	2.98	3.24	2.91	3.06	3.05
Secondary	2.68	2.91	2.99	2.89	3.01	2.90
Postsecondary	2.61	2.78	2.83	2.75	2.85	2.81
Unknown	2.69	2.68	2.99	2.87	2.43	2.82
Underlying Cause						
Diabetes	3.46	3.73	3.79	3.68	4.00	3.69
Hypertension etc.	2.91	3.10	3.29	2.85	3.27	3.17
Septicemia	2.90	3.27	3.73	2.60	2.29	3.36
Chronic pulmonary	2.88	3.08	3.07	3.29	3.20	3.20
Nephritis etc.	2.87	3.18	2.84	3.82	3.93	3.57
Pneumonia and flu	2.71	3.14	3.22	3.11	3.11	3.32
Heart disease	2.79	3.00	3.12	3.05	3.12	3.01
Cerebrovascular	2.60	2.90	3.06	2.98	2.63	2.72
Chronir liver etc.	2.93	3.56	3.43	3.30	3.46	3.10
Atherosclerosis	2.66	3.50	2.83	2.80	3.00	2.88
HIV	2.24	2.71	3.00	2.00	2.40	2.40
Malignant neoplasms	2.18	2.41	2.41	2.37	2.46	2.36
Accident	3.43	3.12	3.33	3.17	3.72	3.05
Suicide	2.62	2.44	2.60	2.33	2.63	2.42
Homicide	2.85	3.02	3.57	3.35	2.50	2.91
Residual causes	2.89	3.31	3.46	3.06	3.51	3.31
Age Group						
25-29	2.61	2.63	2.93	2.77	2.55	2.62
30-34	2.59	2.60	2.92	2.69	2.57	2.57
35-39	2.55	2.54	2.56	2.25	2.88	2.40
40-44	2.50	2.50	2.51	2.49	2.68	2.45
45-49	2.46	2.36	2.67	2.52	2.68	2.56
50-54	2.43	2.54	2.70	2.44	2.72	2.64
55-59	2.46	2.52	2.54	2.76	2.66	2.71
60-64	2.51	2.79	2.65	2.76	2.90	2.75
65-69	2.59	2.79	2.93	2.83	3.06	2.98
70-74	2.67	2.89	2.89	2.86	2.94	3.02
75-79	2.74	3.01	3.04	3.17	3.19	3.08
80-84	2.78	3.00	3.11	2.97	3.28	3.16
85+	2.76	3.03	3.23	3.04	3.29	3.14

Source: U. S. Dept. of Health and Human Services, National Center for Health Statistics. Multiple Cause of Death 1997.

(Continued)

(Table 3, Continued)

	White	Chinese	Japanese	Korean	Vietnamese	Other
Marital Status						
Never-Married Single	2.67	2.72	2.89	2.92	2.71	2.75
Married	2.64	2.86	2.97	2.76	2.92	2.88
Widowed	2.74	2.99	3.11	2.98	3.12	3.03
Divorced	2.65	2.62	2.89	2.84	3.11	2.73
Unknown	2.55	2.31	2.00	2.75	2.33	2.40
Region						
West	2.84	3.03	3.05	3.03	3.11	3.14
Non-West	2.65	2.64	2.49	2.43	2.48	2.58
Nativity						
Native-born	2.68	2.90	3.02	3.12	3.00	2.73
Foreign-born	2.69	2.88	2.94	2.83	2.97	2.92
Unknown	2.68	2.28	3.29	2.00	1.00	2.24

Source: U. S. Dept. of Health and Human Services, National Center for Health Statistics. Multiple Cause of Death 1997.

Table 4. Odds Ratios of the Effects of Sociodemographic Factors and Underlying Medical Causes on Dying with Four or More TC

	Model 1	Model 2
Age	1.008 ***	1.007 ***
Region		
West	ref.	ref.
Non-West	0.758 ***	0.751 ***
Sex		
Male	1.052 ***	1.041 ***
Female	ref.	ref.
Race		
White	ref.	ref.
Chinese	1.182	1.228
Japanese	1.209	1.241
Korean	1.215	1.245
Vietnamese	1.361 *	1.390 **
Other API	1.378 ***	1.347 ***
Marital Status		
Never-Married Single	1.033 ***	0.943 ***
Married	ref.	ref.
Widowed	1.019 ***	0.962 ***
Divorced	1.022 ***	0.968 ***
Unknown	0.839 ***	0.749 ***
Nativity		
Native-born	ref.	ref.
Foreign-born	0.912 ***	0.913 ***
Unknown	1.007	0.984
Education Level		
Primary	1.178 ***	1.149 ***
Secondary	1.111 **	1.099 ***
Postsecondary	ref.	ref.
Unknown	1.124 ***	1.101 **
Underlying Cause		
Diabetes		1.722 ***
Hypertension		0.849
Septicemia		0.967 ***
COPD		0.891 ***
Nephritis, neph. syndrome, nephrosis		0.904 ***
Pneumonia and influenza		0.705 ***
Heart disease		0.846 ***
Cerebrovascular disease		0.671 ***
Chronic liver disease and cirrhosis		1.068 ***
Atherosclerosis		0.654 ***
HIV		0.518 ***
Malignant neoplasms		0.428 ***
Accident		1.628 ***
Suicide		0.468 ***
Homicide		0.796
Residual causes		ref.
-2 Log-Likelihood	2,103,608.4	2,059,915.7
Chi-Square	9,875.3 ***	54,045.0 ***
Degrees of freedom	17	32
n	1,887,793	1,887,793

* p < 0.05; ** p < 0.01; ** p < 0.001

Source: U. S. Dept. of Health and Human Services, National Center for Health Statistics. Multiple Cause of Death 1997.

Table 5. Odds Ratios of the Effects of Sociodemographic Factors and Underlying Medical Causes on Dying with Four or More TC by Race

	White	Chinese	Japanese	Other API
Age	1.007 **	1.007 **	1.006 *	1.011 ***
Region				
West	ref.	ref.	ref.	ref.
Non-West	0.756 ***	0.525 ***	0.599 ***	0.521 ***
Sex				
Male	1.040 ***	1.132 *	0.955	1.033 *
Female	ref.	ref.	ref.	ref.
Marital Status				
Never-Married Single	0.943 **	0.908	0.879	1.049
Married	ref.	ref.	ref.	ref.
Widowed	0.962 ***	1.040	0.919	0.982
Divorced	0.968 ***	0.781	0.913	0.998
Unknown	0.750 ***	0.887	<0.001 [a]	0.856
Nativity				
Native-born	ref.	ref.	ref.	ref.
Foreign-born	0.910 ***	1.180	0.892	1.270
Unknown	0.989	0.647	2.711	0.597
Education Level				
Primary	1.148 ***	1.023	1.274	0.987
Secondary	1.099 ***	1.038	1.184	1.024
Postsecondary	ref.	ref.	ref.	ref.
Unknown	1.102 **	0.906	1.164	0.949
Underlying Cause				
Diabetes	1.725 ***	1.356 ***	1.304 ***	1.452 ***
Hypertension	0.854	0.522	0.321	0.686
Septicemia	0.968 ***	0.549	1.123 *	1.026 *
COPD	0.894 ***	0.633	0.483	0.705
Nephritis, neph. syndrome, nephrosis	0.903 ***	0.824	0.406	1.083 *
Pneumonia and influenza	0.702 ***	0.682	0.751	0.881 *
Heart disease	0.848 ***	0.657	0.701	0.692
Cerebrovascular disease	0.674 ***	0.541 *	0.524	0.423 ***
Chronic liver disease and cirrhosis	1.068 ***	1.358 *	1.020	0.913
Atherosclerosis	0.657 ***	0.894	0.236	0.404
HIV	0.519 ***	1.265	0.443	0.380
Malignant neoplasms	0.429 ***	0.334 ***	0.305 ***	0.355 ***
Accident	1.652 ***	0.625	0.754	0.638
Suicide	0.474 ***	0.156 ***	0.281 *	0.215 ***
Homicide	0.797	0.625	1.254	0.704
Residual causes	ref.	ref.	ref.	ref.
-2 Log-Likelihood	2,027,782.2	7,889.5	6,004.5	13,735.9
Chi-Square	52,336.2 ***	399.5 ***	290.5 ***	833.5 ***
Degrees of freedom	27	27	27	27
n	1,860,939	6,904	5,005	11,841

* $p < 0.05$; ** $p < 0.01$; ** $p < 0.001$

[a] Because the cell size is very small (n=6), the estimated odds ratio is not reliable

Source: U. S. Dept. of Health and Human Services,
National Center for Health Statistics. Multiple Cause of Death 1997.

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