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The burden of liver cancer in Asians and Pacific Islanders in the Greater San Francisco Bay Area, 1990 through 2004

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Abstract

Background—No previous U.S. study has examined time trends in the incidence rate of liver cancer in the high-risk Asian/Pacific Islander population. We evaluated liver cancer incidence trends in Chinese, Filipino, Japanese, Korean, and Vietnamese males and females in the Greater San Francisco Bay Area of California between 1990 and 2004.

Methods—Populations at risk were estimated using the cohort component demographic method. Annual percentage changes (APCs) in age-adjusted incidence rates of primary liver cancer among Asians/Pacific Islanders in the Greater Bay Area Cancer Registry were calculated using joinpoint regression analysis.

Results—The incidence rate of liver cancer between 1990 and 2004 did not change significantly in Asian/Pacific Islander males or females overall. However, the incidence rate declined, albeit statistically non-significantly, in Chinese males (APC = −1.6% [95% confidence interval (CI) = −3.4%, 0.3%], Japanese males (APC = −4.9%, 95% CI = −10.7%, 1.2%), and Japanese females (APC = −3.6%, 95% CI = −8.9%, 2.0%). Incidence rates remained consistently high for Vietnamese, Korean, and Filipino males and females. Trends in the incidence rate of hepatocellular carcinoma were comparable to those for liver cancer. While disparities in liver cancer incidence between Asians/Pacific Islanders and other racial/ethnic groups diminished between 1990–1994 and 2000–2004, those among Asian subgroups increased.

Conclusions—Liver cancer continues to affect Asian/Pacific Islander Americans disproportionately, with consistently high incidence rates in most subgroups. Culturally targeted prevention methods are needed to reduce the high rates of liver cancer in this growing population in the U.S.

Keywords

Asian Americans; epidemiology; hepatocellular carcinoma; liver cancer; surveillance

Background

Liver cancer is the sixth most common newly diagnosed cancer and the third most common cause of cancer mortality in the world.¹ Although over 80% of liver cancer cases worldwide occur in developing parts of the world, particularly Asia, Melanesia, and Africa,¹ a sizeable and growing proportion of the U.S. population—particularly immigrants from high-incidence regions—is at elevated risk of developing liver cancer. Previous studies have examined the incidence rate of liver cancer in U.S. White, Black, and Hispanic populations,^{2, 3} in whom the incidence rate of hepatocellular carcinoma (HCC) rose by over 90% between 1976 and 2000.⁴ However, none of these studies examined trends in Asian/Pacific Islander (API) Americans—the racial group at highest risk of liver cancer⁵ and with the fastest growth rate in the U.S.⁶ Moreover, because the classification of APIs into an aggregated racial group—an established practice in population and health statistics—ignores the substantial heterogeneity among dozens of racial/ethnic subgroups, little is known about the pattern of disease occurrence, including changes in incidence over time, within such subgroups. As a result, culturally targeted interventions designed to improve the prevention of and screening for liver cancer based on aggregated statistics may not be aimed at the Asian subgroups at greatest risk.

The Greater San Francisco Bay Area in California, U.S., has the highest concentration of APIs in the continental U.S. (23%),⁷ making it an ideal region in which to examine cancer incidence patterns across Asian subgroups. Therefore, we set out to evaluate secular trends in liver cancer incidence rates for APIs combined and Chinese, Japanese, Filipino, Korean, and Vietnamese males and females between 1990 and 2004. We also assessed secular changes in the burden of liver cancer, measured as the difference between the proportion of liver cancer cases and the proportion of the total population represented by specific Asian subgroups, and the rank of liver cancer among all cancer sites.

Methods

Case data

Patients included in this study were incident cases of primary malignant liver cancer (International Classification of Diseases for Oncology, 2nd edition [ICD-O-2]⁸ or ICD-O-3⁹ site code 22.0, histology codes 8000–8999) diagnosed between January 1, 1990 and December 31, 2004 while resident in the nine counties of the Greater San Francisco Bay Area that form the catchment area for the Greater Bay Area Cancer Registry (GBACR). The GBACR is a participant in the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) program and in the state-mandated California Cancer Registry. Secondary analyses were limited to HCC (ICD-O-2 or ICD-O-3 histology codes 8170–8180), the predominant form of liver cancer. Information about patients' race/ethnicity in the GBACR is obtained routinely from hospital medical records, in which it is collected primarily through patient self-report, but may sometimes also be collected by assumption of hospital personnel or from inference based on other information including race/ethnicity of parents, birthplace, maiden name, or surname.¹⁰

Population data

Updated annual mid-year population estimates between 1990 and 2004 were provided by the State of California Department of Finance (DOF) Demographic Research Unit by age, sex, and race/ethnicity for each county. Because the DOF does not estimate annual population counts for Asian American (hereafter referred to as "Asian") subgroups, we computed annual population estimates between 1990 and 2004 separately for the six largest Asian populations in the Greater San Francisco Bay Area: Chinese, Filipino, Japanese, Korean, South Asian, and Vietnamese. We also analyzed all APIs combined, including these six groups as well as APIs

of other or unknown subgroups. Because of sparse cancer case numbers, analyses were not conducted for South Asians as a separate subgroup. Hispanic Asians were excluded because they comprise a distinct ethnic group.

For the census years 1990 and 2000, we used census totals (from the 100% sample) as population estimates. Because respondents were allowed to identify with more than one race category in the 2000 census, we used a bridging methodology to reallocate all multi-race individuals (10% of APIs in the GBACR region¹¹) into single-race categories, using allocation percentages provided by the DOF.^{12, 13} For the intercensal years 1991–1999, we used the same DOF cohort component method¹⁴ to estimate the annual age-, sex-, and county-specific intercensal population for each Asian subgroup by using the population counts from 1990 and 2000 and incorporating annual DOF immigration data for each county, and birth and death counts from vital statistics data for each year within the intercensal period. We estimated postcensal (2001 through 2004) populations by extrapolation from the 2000 populations using a constant allocation method within each county and sex. Based on this method, the relative proportions of each age-specific Asian subgroup in 2000 were applied to the bridged 2001 through 2004 combined Asian population for the same county and sex groups.

Incidence rates were compared using bridged and unbridged population estimates, and the differences were insubstantial. Here we present bridged estimates, as they are likely to yield a more accurate estimate of the true incidence rate due to the high proportion of multi-race individuals in relatively small Asian subgroups.

The population estimates used in this study are generally <10% different from the SEER program's estimates provided by the U.S. Census Bureau (Tim Miller, personal communication, 2006). However, the Census estimates for APIs tend to be higher in age groups above 70 years during the intercensal period. Both population estimates use bridging methods to allocate multi-race individuals into single-race groups, based on different allocation percentages. Age-adjustment of rates tends to smooth over any differences between the population estimates.

Statistical analysis

We used SEER*Stat software¹⁵ to compute average annual age-adjusted incidence rates of cancer (standardized to the 2000 U.S. standard million population) and 95% confidence intervals (CIs) for males and females.

Time trends in the incidence rate between 1990 and 2004 were analyzed using Joinpoint Regression Program software^{16, 17} to fit a series of regression lines to the age-adjusted incidence rates on the logarithmic scale, with calendar year as the regressor variable. The slope of each line segment describes the annual percentage change (APC) in the incidence rate, and line segments are connected at “joinpoints” that denote a statistically significant change in trend ($P < 0.05$). A minimum of zero joinpoints (one line segment) and a maximum of three joinpoints (four line segments) were allowed for each model, which was selected to minimize the number of joinpoints needed for the best fit. A minimum of two observations was required between joinpoints or from a joinpoint to either end of the data.

To summarize secular trends graphically, we grouped age-adjusted incidence rates by 5-year periods (1990–1994, 1995–1999, and 2000–2004) in order to stabilize estimates and to examine other changes in the relative incidence and mortality of liver cancer over time. Specifically, we quantified the burden of liver cancer as the proportion of liver cancer cases in APIs or each Asian subgroup, divided by the proportion of the total Greater Bay Area population (including both APIs and non-APIs) represented by that group. We also assessed the relative importance of liver cancer within each group by ranking the frequency of liver cancer incidence or mortality

among all invasive cancer sites in the GBACR at the start of the study period (1990–1994) and at the end (2000–2004). Cancers of the oral cavity and pharynx, the colon and rectum, or the brain and nervous system were grouped together for the latter analysis, in accordance with similar ranking methods.¹⁸

To quantify racial/ethnic disparities in liver cancer incidence, we compared APIs with non-APIs (including non-Hispanic Whites, non-Hispanic Blacks, Hispanics, and others), as well as Asian subgroups with each other, using three summary measures. The between-group variance was used to measure the absolute level of racial/ethnic disparity in the age-adjusted incidence rate of liver cancer over time, while the Theil index and the mean log deviation were used to measure the relative level of racial/ethnic disparity.¹⁹ The Theil index is more influenced by population subgroups with relatively high incidence rates, whereas the mean log deviation is more influenced by population subgroups of larger size.

Results

Incidence rates of liver cancer in Asian subgroups in the Greater Bay Area between 1990 and 2004 ranged from 6.9 to 65.7 per 100,000 person-years in males and 4.5 to 23.9 per 100,000 person-years in females (Table 1). In the Greater Bay Area in 2000–2004, liver cancer incidence rates per 100,000 person-years among males were 6.6 (95% CI = 6.0, 7.1) in non-Hispanic Whites; 15.3 (95% CI = 12.9, 18.2) in non-Hispanic Blacks; and 15.1 (95% CI = 13.2, 17.3) in Hispanics. Among females, they were 2.1 (95% CI = 1.8, 2.4) in non-Hispanic Whites, 4.8 (95% CI = 3.6, 6.3) in non-Hispanic Blacks; and 5.8 (95% CI = 4.8, 7.0) in Hispanics. By comparison, age-adjusted incidence rates (standardized to the 2000 U.S. standard million population) of liver cancer in China, Japan, Korea, Vietnam, and the Philippines between 1993 and 1997 generally ranged from 30 to 70 per 100,000 person-years in males and from 10 to 20 per 100,000 person-years in females.²⁰

The liver cancer incidence rate in API males overall concealed heterogeneity in rates and time trends among Asian subgroups (Figure 1, Table 1). The rate of liver cancer over time decreased marginally in Chinese males and Japanese males, whereas it was relatively stable in Filipino, Korean, and Vietnamese males. Incidence rates were consistently highest in Vietnamese males, followed by Korean or Chinese males, then Filipinos and Japanese. In API females, the level trend again disguised considerable variation among Asian subgroups, with a suggestive rate decline in Japanese females, but no significant change in Chinese, Filipina, or Vietnamese females. The incidence rate of liver cancer appeared to have increased over time in Korean females (Figure 2, Table 1), but the APC could not be estimated due to limited case numbers. Among females, incidence rates were highest in Vietnamese and Koreans, followed by Chinese, Japanese, and Filipinas.

HCC comprised over 90% of primary liver cancers in males and over 85% in females in most Asian subgroups; these proportions did not vary substantially over time (data not shown). Therefore, secular trends for HCC between 1990 and 2004 closely paralleled those for liver cancer overall, with indications of a decrease in Chinese males (APC = −1.5%, 95% CI = −3.5%, 0.6%), Japanese males (APC = −4.4%, 95% CI = −10.4%, 2.1%) and Japanese females (APC = −2.9%, 95% CI = −8.3%, 2.7%) (other data not shown).

The burden of incident liver cancer was largest in Chinese and Vietnamese males, and Korean and Vietnamese females, relative to the total Greater Bay Area population (Table 2). Disparities in liver cancer incidence were somewhat lessened over time, as the imbalance among Asian subgroups—with some exceptions, such as Vietnamese males and females generally—diminished between 1990–1994 and 2000–2004 (with intermediate values in 1995–1999, data not shown).

Liver cancer was a leading cause of cancer incidence and death in API males, ranking among the five most common cancer sites for most Asian subgroups (Table 3). Because survival with liver cancer is poorer than that of most other cancer sites, its ranking as a cause of cancer mortality was generally higher than that for cancer incidence. In females, liver cancer generally ranked lower than in males as a cause of cancer incidence and mortality (Table 3), reflecting the roughly 3:1 male:female ratio in most racial/ethnic groups (Table 1). Nevertheless, liver cancer was one of the seven most common causes of cancer death in females of all Asian subgroups in 2000–2004. The ranking of liver cancer incidence and mortality among all cancer sites remained in the top 14 for incidence and the top 10 for mortality between 1990–1994 and 2000–2004 (1995–1999 data not shown) in all subgroups of Asian males and females.

Summary measures of health disparity comparing APIs with non-APIs overall showed that both the absolute and the relative racial/ethnic disparity in the age-adjusted incidence rate of liver cancer diminished over time (Table 4; 1995–1999 data not shown). However, the absolute and relative disparity in liver cancer incidence among Asian subgroups increased during the same time period.

Discussion

We found that the high incidence rate of liver cancer (and HCC in particular) in the API population of the Greater Bay Area, California, remained steady in APIs overall and most Asian subgroups between 1990 and 2004, with differences in rates and trends noted across subgroups. While the rate decreased in Chinese males and Japanese males and females, it did not change significantly in Vietnamese or Korean males or females—that is, in the subgroups with the highest incidence rates of liver cancer—nor did it change appreciably in Chinese females or Filipinos. Although national incidence rates and time trends are not available for API subgroups, our findings among all APIs combined in the Greater Bay Area were comparable with those for APIs in the overall U.S. (incidence rate of liver and intrahepatic bile duct cancer per 100,000 person-years in 1999–2003 = 22.1 in API males, 8.3 in API females; no significant change from 1995 through 2003).³ The stable or decreasing trends in API subgroups in the Greater Bay Area are at variance with the rising liver cancer incidence in other racial/ethnic groups in the U.S. over recent decades.^{2–4} The enduring high incidence rates in APIs and Asian subgroups, combined with the escalating trends in Hispanics, Whites, and Blacks, make clear that enhancing liver cancer awareness and prevention is a major public health priority for all Americans.

The increasing liver cancer incidence rates in Hispanics, Whites, and Blacks have generally been attributed to the spread of hepatitis C virus (HCV) infection in the U.S., as reflected by the two- to four-fold increase in the incidence of acute HCV infection between the early 1960s and the late 1980s.²¹ In contrast, the disproportionately high rate of liver cancer incidence in APIs is ascribed primarily to the high prevalence of chronic hepatitis B virus (HBV) infection, which is etiologically associated with the majority of liver cancer in Asian natives and migrants.^{22, 23} Chronic HBV infection is carried by approximately 10% of the population in eastern and southeastern Asia and sub-Saharan Africa, as well as immigrants from those regions, whereas the prevalence is estimated at below 0.5% in the overall U.S. population.²⁴ The suggestion of a decline in the Chinese and Japanese populations may be due in part to the fact that immigrants from China and Japan have been settling in the U.S. since the mid-19th century.²⁵ Because HBV is non-endemic in the U.S., acculturated Asians may be less likely than more recently immigrated Asians to acquire HBV infection through horizontal transmission in early childhood or adulthood. Lower rates of transmission, in turn, reduce the prevalence of chronic HBV infection, which most commonly follows infection during early childhood or birth to an infected mother.²⁴ In concert with our results showing a flat or even decreasing time trend in liver cancer incidence in Asian subgroups, two U.S.-based studies found that the occurrence

of HBV-related liver cancer in Veterans Affairs Medical Centers²⁶ or in a Houston medical center²⁷ remained stable or declined between 1993 and 1998.

Although a safe and effective vaccine against HBV has existed since 1982,²⁸ the population-wide incidence rate of liver cancer in APIs and most Asian subgroups may not yet have decreased because liver cancer usually occurs in adults, many of whom were chronically infected with HBV before the vaccine was introduced. Nevertheless, few Asian countries—with the exception of Taiwan^{29, 30} and Malaysia³¹—have been quick to adopt universal newborn HBV vaccination programs, and the majority of APIs in the U.S. are foreign-born.³² Therefore, the continuing influx of API immigrants into the U.S.⁶ will likely sustain the high prevalence of chronic HBV infection and the high incidence rate of liver cancer in API adults for several years to come, unless preventive public health steps are taken.

As further evidence of the need for preventive measures, the persistence of liver cancer as a leading cause of cancer mortality in APIs and all Asian subgroups in our study suggests that chronic HBV carriers are not being identified, treated for chronic HBV infection,³³ and regularly screened for early liver cancer, which is more amenable to treatment when detected early.³⁴ Although the U.S. Advisory Committee on Immunization Practices (ACIP) recommends universal vaccination of newborns, children, adolescents, and high-risk adults (including heterosexuals with multiple sex partners, injection-drug users, and men who have sex with men),^{35, 36} there is no recommendation for HBV testing in all APIs, nor are there universally accepted guidelines for liver cancer screening. Furthermore, APIs are not broadly recognized as a high-risk group, creating barriers in access to HBV testing and vaccination for API adults.

Some limitations of our study should be considered. We lacked data on whether liver cancer cases were secondary to chronic HBV or HCV infection, alcoholic cirrhosis, or a combination of these factors, and we also had no knowledge of other risk factors such as diet, alcohol intake, obesity, and diabetes. Therefore, although incidence rates were generally steady, we were unable to determine whether the proportions of liver cancer associated with certain risk factors changed over time. In general, there are no population-based data on the seroprevalence of chronic HBV infection in Asian subgroups, although the annual incidence rate of acute HBV infection did not change in the overall U.S. between the late 1970s and the early 1990s.³⁷ We also lacked information on patients' screening, vaccination, and anti-viral treatment³⁸ practices, and were therefore unable to evaluate whether these activities affected liver cancer incidence. In addition, when quantifying secular changes in the proportion of liver cancer cases compared with the population, and in the ranking of liver cancer among all cancer sites, we did not account for variation and changes in the distribution of age or other population characteristics. The ranking of liver cancer incidence and mortality among all cancer sites can be affected by changes in the occurrence of other cancers; however, the high ranking of liver cancer emphasizes that it should be a prominent target in the effort to reduce the nationwide cancer burden. Another limitation is the potential for misclassification of Asian subgroups in cancer registry and/or population data,^{39–41} although it is unlikely that such misclassification changed substantially during the study period. Finally, the statistical power of our analysis was limited by the small number of observed liver cancer cases in some population subgroups.

In conclusion, our results demonstrate that liver cancer incidence in the Greater Bay Area remained high in API, Vietnamese, Korean, and Filipino males and females and Chinese females between 1990 and 2004, with some evidence of a decrease in Chinese males and Japanese males and females. The lack of a decline in most Asian subgroups indicates that liver cancer prevention through HBV testing, vaccination, and treatment, as well as liver cancer screening, remains a top priority in the API population. We also observed that disparities in liver cancer incidence among Asian subgroups widened from 1990 through 2004. In particular,

the Vietnamese, Korean, and Filipino American populations should be the focus of culturally and linguistically targeted HBV and liver cancer education, prevention, and screening efforts. Such intensified public health efforts are necessary to curtail the expanding nationwide burden of liver cancer in all racial/ethnic groups.

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References

1. Parkin DM, Bray F, Ferlay J, Pisani P. Global cancer statistics, 2002. *CA Cancer J Clin* 2005;55(2): 74–108. [PubMed: 15761078]
2. El-Serag HB, Mason AC. Rising incidence of hepatocellular carcinoma in the United States. *N Engl J Med* 1999;340(10):745–50. [PubMed: 10072408]
3. Howe HL, Wu X, Ries LA, et al. Annual report to the nation on the status of cancer, 1975–2003, featuring cancer among U.S. Hispanic/Latino populations. *Cancer* 2006;107(8):1711–42. [PubMed: 16958083]
4. McGlynn, KA.; Tarone, RE.; El-Serag, HB. A comparison of trends in the incidence of hepatocellular carcinoma and intrahepatic cholangiocarcinoma in the United States; *Cancer Epidemiol Biomarkers Prev.* 2006. p. 1198-203. Available from <http://cebp.aacrjournals.org/cgi/content/abstract/15/6/1198>
5. Chen MS Jr. Cancer health disparities among Asian Americans: what we do and what we need to do. *Cancer* 2005;104(12 Suppl):2895–902. [PubMed: 16270313]
6. United States Census Bureau. Hispanic and Asian Americans increasing faster than overall population. Jun 14. 2004 <http://www.census.gov/Press-Release/www/releases/archives/race/001839.html> [accessed February 18, 2006]
7. United States Census Bureau. U.S. Department of Commerce, Economics and Statistics Administration, 2006. 2005. American Community Survey.
8. Percy, C.; Van Holten, B.; Muir, C. International Classification of Diseases for Oncology. Vol. 2. Geneva: World Health Organization; 1990.
9. Fritz, A.; Percy, C.; Jack, ASS.; Sobin, L.; Parkin, DM.; Whelan, S. International Classification of Diseases for Oncology. Vol. 3. Geneva: World Health Organization; 2000. p. 240
10. Gomez SL, Le GM, West DW, Satariano WA, O'Connor L. Hospital policy and practice regarding the collection of data on race, ethnicity, and birthplace. *Am J Public Health* 2003;93(10):1685–8. [PubMed: 14534222]
11. United States Census Bureau, Census 2000 Summary File 2. U.S. Department of Commerce, Economics and Statistics Administration, 2001.
12. State of California Department of Finance, Suggested Allocations of the Multirace Category for Use with Population Projections by Race/Ethnicity for California and Its Counties, 2000–2050, 2004.
13. Gomez, SL.; Le, GM.; Miller, T., et al. Cancer Incidence Among Asians in the Greater Bay Area, 1990–2002. Northern California Cancer Center; 2005. Available at: http://www.nccc.org/pdf/Registries/annual_reports/Special_Report_Cancer_Asiatics_1990-2002.pdf
14. Shryock, HS.; Siegel, JS., et al. The Methods and Materials of Demography. Washington, D.C.: U.S. Department of Commerce, Bureau of the Census; 1973.

15. Surveillance Research Program, National Cancer Institute. SEER*Stat software. 2005. (www.seer.cancer.gov/seerstat) version 6.1.4
16. Surveillance Research Program, National Cancer Institute. Joinpoint Regression Program software (srab.cancer.gov/joinpoint) version 3.0, 2005.
17. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. *Stat Med* 2000;19(3):335–51. [PubMed: 10649300]
18. American Cancer Society, Cancer Facts & Figures 2007. American Cancer Society, 2007.
19. Harper, S.; Lynch, J. NCI Cancer Surveillance Monograph Series, Number 6. NIH Publication No. 05–5777. Bethesda, MD: National Cancer Institute; 2005. Methods for Measuring Cancer Disparities: Using Data Relevant to Healthy People 2010 Cancer-Related Objectives.
20. Parkin, DM.; Whelan, SL.; Ferlay, J.; Storm, H. Cancer Incidence in Five Continents, Vol. I to VIII. Lyon: IARC CancerBase No. 7; 2005. Updated and original databases at <http://www-dep.iarc.fr/>
21. Armstrong GL, Alter MJ, McQuillan GM, Margolis HS. The past incidence of hepatitis C virus infection: implications for the future burden of chronic liver disease in the United States. *Hepatology* 2000;31(3):777–82. [PubMed: 10706572]
22. Parkin DM. The global health burden of infection-associated cancers in the year 2002. *Int J Cancer* 2006;118(12):3030–44. [PubMed: 16404738]
23. Hwang SJ, Tong MJ, Lai PP, et al. Evaluation of hepatitis B and C viral markers: clinical significance in Asian and Caucasian patients with hepatocellular carcinoma in the United States of America. *J Gastroenterol Hepatol* 1996;11(10):949–54. [PubMed: 8912133]
24. Custer B, Sullivan SD, Hazlet TK, Iloeje U, Veenstra DL, Kowdley KV. Global epidemiology of hepatitis B virus. *J Clin Gastroenterol* 2004;38(10 Suppl):S158–68. [PubMed: 15602165]
25. Daniels, R. Asian America: Chinese and Japanese in the United States Since 1850. Seattle, WA: University of Washington Press; 1988.
26. El-Serag HB, Mason AC. Risk factors for the rising rates of primary liver cancer in the United States. *Arch Intern Med* 2000;160(21):3227–30. [PubMed: 11088082]
27. Hassan MM, Frome A, Patt YZ, El-Serag HB. Rising prevalence of hepatitis C virus infection among patients recently diagnosed with hepatocellular carcinoma in the United States. *J Clin Gastroenterol* 2002;35(3):266–9. [PubMed: 12192205]
28. Recommendations of the Immunization Practices Advisory Committee (ACIP). Hepatitis B virus: a comprehensive strategy for eliminating transmission in the United States through universal childhood vaccination. *MMWR Recomm Rep* 1991;40(RR–13):1–25.
29. Chen DS, Hsu NH, Sung JL, et al. A mass vaccination program in Taiwan against hepatitis B virus infection in infants of hepatitis B surface antigen-carrier mothers. *Jama* 1987;257(19):2597–603. [PubMed: 3573257]
30. Chen HL, Chang MH, Ni YH, et al. Seroepidemiology of hepatitis B virus infection in children: Ten years of mass vaccination in Taiwan. *Jama* 1996;276(11):906–8. [PubMed: 8782640]
31. Ng KP, Saw TL, Baki A, Rozainah K, Pang KW, Ramanathan M. Impact of the Expanded Program of Immunization against hepatitis B infection in school children in Malaysia. *Med Microbiol Immunol (Berl)* 2005;194(3):163–8. [PubMed: 15834754]
32. United States Census Bureau. We the People: Asians in the United States. Census 2000 Special Reports. U.S. Department of Commerce, Economics and Statistics Administration; 2004.
33. Dienstag JL, Schiff ER, Wright TL, et al. Lamivudine as initial treatment for chronic hepatitis B in the United States. *N Engl J Med* 1999;341(17):1256–63. [PubMed: 10528035]
34. Nguyen MH, Keffe EB. Screening for hepatocellular carcinoma. *J Clin Gastroenterol* 2002;35(5 Suppl 2):S86–91. [PubMed: 12394211]
35. Recommendations of the Advisory Committee on Immunization Practices, the American Academy of Pediatrics, the American Academy of Family Physicians, and the American Medical Association. Immunization of adolescents. *MMWR Recomm Rep* 1996;45(RR13):1–16.
36. Update: recommendations to prevent hepatitis B virus transmission--United States. *MMWR Morb Mortal Wkly Rep* 1999;48(2):33–4. [PubMed: 9933127]

37. Coleman PJ, McQuillan GM, Moyer LA, Lambert SB, Margolis HS. Incidence of hepatitis B virus infection in the United States, 1976–1994: estimates from the National Health and Nutrition Examination Surveys. *J Infect Dis* 1998;178(4):954–9. [PubMed: 9806021]
38. Hoofnagle, JH. Hepatitis B -- preventable and now treatable; *N Engl J Med*. 2006. p. 1074-76. Available from <http://content.nejm.org>
39. Swallen KC, Glaser SL, Stewart SL, West DW, Jenkins CN, McPhee SJ. Accuracy of racial classification of Vietnamese patients in a population-based cancer registry. *Ethn Dis* 1998;8(2):218–27. [PubMed: 9681287]
40. Gomez SL, Glaser SL, Kelsey JL, Lee MM, Sidney S. Inconsistencies between self-reported ethnicity and ethnicity recorded in a health maintenance organization. *Annals of Epidemiology* 2005;15:71–79. [PubMed: 15571996]
41. Gomez SL, Glaser SL. Misclassification of race/ethnicity in a population-based cancer registry (United States). *Cancer Causes Control* 2006;17(6):771–81. [PubMed: 16783605]

Figure 1. Age-adjusted incidence rate of liver cancer in Greater Bay Area Asian/Pacific Islander males, 1990–2004. Data points are offset for visibility. Error bars denote 95% confidence intervals.

Figure 2. Age-adjusted incidence rate of liver cancer in Greater Bay Area Asian/Pacific Islander females, 1990–2004. Data points are offset for visibility. Error bars denote 95% confidence intervals.

Table 1

Age-adjusted incidence rate of liver cancer over time in Asian subgroups

Incidence rate of primary liver cancer per 100,000 person-years, age-standardized to the U.S. 2000 population, with 95% confidence interval (CI) and annual percent change (APC) in rate in Asians/Pacific Islanders and subgroups in the Greater Bay Area, 1990–2004

Sex	Race/ethnicity	1990–1994			1995–1999			2000–2004			APC	(95% CI)
		Cases (N)	Rate	(95% CI)	Cases (N)	Rate	(95% CI)	Cases (N)	Rate	(95% CI)		
Males	Asian/Pacific Islander	389	24.7	(22.2, 27.5)	519	24.9	(22.7, 27.3)	661	22.9	(21.2, 24.8)	−0.4%	(−1.8, 1.0%)
	Chinese	198	28.8	(24.7, 33.7)	264	29.1	(25.5, 33.1)	297	24.1	(21.4, 27.1)	−1.6%	(−3.4, 0.3%)
	Filipino	64	16.6	(12.7, 21.5)	63	12.8	(9.7, 16.8)	104	16.1	(13.1, 19.6)	−0.3%	(−3.2, 2.8%)
	Japanese	21	14.1	(8.2, 23.7)	22	11.8	(7.2, 19.4)	17	6.9	(4.0, 11.5)	−4.9%	(−10.7, 1.2%)
	Korean	17	26.9	(15.2, 57.6)	31	39.1	(25.5, 61.3)	34	33.6	(22.5, 49.5)	1.9%	(−2.8, 6.9%)
Females	Vietnamese	55	55.6	(39.3, 83.9)	102	65.7	(50.8, 85.5)	135	53.0	(43.6, 64.6)	0.2%	(−4.4, 5.1%)
	Asian/Pacific Islander	134	7.7	(6.4, 9.3)	212	8.5	(7.3, 9.8)	233	6.7	(5.9, 7.7)	−1.2%	(−3.3, 1.1%)
	Chinese	62	8.5	(6.5, 11.0)	83	7.8	(6.2, 9.7)	96	6.6	(5.3, 8.1)	−1.8%	(−4.8, 1.3%)
	Filipina	22	5.4	(3.1, 9.1)	34	5.8	(3.9, 8.4)	38	4.5	(3.2, 6.3)	−2.3%	(−6.5, 2.4%)
	Japanese	23	8.3	(4.9, 13.9)	23	6.7	(4.2, 10.9)	22	5.2	(3.2, 8.7)	−3.6%	(−8.9, 2.0%)
	Korean	5	8.1	(2.5, 23.9)	16	15.2	(8.4, 26.5)	16	12.1	(6.8, 20.3)	~	
	Vietnamese	14	13.3	(6.9, 27.6)	39	23.9	(16.4, 34.8)	37	14.5	(10.1, 20.6)	−0.1%	(−6.9, 7.3%)

~ Could not be estimated

Table 3

Relative importance of liver cancer over time in Asian subgroups

Rank of primary liver cancer incidence and mortality among all cancer sites in Asians/Pacific Islander and subgroups in the Greater Bay Area, 1990–1994 and 2000–2004

Race/ethnicity	Males				Females			
	Incidence 1990–1994	Incidence 2000–2004	Mortality 1990–1994	Mortality 2000–2004	Incidence 1990–1994	Incidence 2000–2004	Mortality 1990–1994	Mortality 2000–2004
Asian/Pacific Islander								
Chinese	4th	4th	2nd	3rd	12th	11th	5th	6th
Filipino	4th	4th	2nd	2nd	11th	10th	4th	6th
Japanese	5th	5th	4th	5th	14th	13th	10th	7th
Korean	8th	10th	7th	6th	8th	9th	6th	7th
Vietnamese	4th	3rd	3rd	4th	7th	5th	4th	5th
	2nd	2nd	2nd	2nd	8th	6th	6th	3rd

Table 4
Summary metrics of disparities in liver cancer incidence over time

Absolute (between-group variation) and relative (Theil index and mean log deviation) measures of disparities in the age-adjusted incidence rate of liver cancer, comparing Asians/Pacific Islanders with non-Asians/Pacific Islanders or comparing Asian subgroups, 1990–1994 and 2000–2004

Sex	Measure of disparity	Asian/Pacific Islander vs. non-Asian/Pacific Islander 1990–1994	2000–2004	Chinese vs. Filipino vs. Japanese vs. Korean vs. Vietnamese 1990–1994	2000–2004
Males	Between-group variation	42.72	34.01	158.68	165.30
	Theil index	0.28	0.12	0.19	0.20
	Mean log deviation	0.14	0.08	0.01	0.05
Females	Between-group variation	4.11	2.59	5.31	10.92
	Theil index	0.32	0.10	0.06	0.17
	Mean log deviation	0.09	0.06	0.02	0.02