

## RESEARCH COMMUNICATION

# Ethnic Disparities in Cancer Incidence among Residents of Guam

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### Abstract

Cancer incidence data collected by the Guam Cancer Registry for the period 1998 through 2002 were analyzed by cancer site, age, and ethnicity. Ethnicity and site specific age-adjusted cancer incidence rates for Guam residents were calculated utilizing Guam 2000 census data and the U.S. 2000 standard population and were compared to U.S. 2000 data. Age-adjusted total cancer incidence rates per 100,000 population for the major ethnic groups represented on Guam were generally lower than U.S. averages (the exception was the Caucasian group which was higher). Some highlights include: 1). Chamorros (the indigenous people of the Mariana Islands) living on Guam had a slightly lower total cancer incidence rate than the total U.S. population (406.8/100,000 vs. 478.6 U.S.). Chamorros had high age-adjusted incidence rates for cancers of the mouth and pharynx (24.4 vs. U.S. 10.7), nasopharynx (13.9 vs. 0.6 U.S.), liver (13.2 vs. 5.2 U.S.), and cervix (16.2 vs. 9.6 U.S.). Rates for prostate cancer (103.9 vs. 167.7 U.S.), female breast (115.9 vs. 130.9 U.S.), ovary (7.0 vs. 14.2 U.S.), colon-rectum-anus (44.3 vs. 56.9 U.S.), leukemia (11.0 vs. 12.6 U.S.), and non-Hodgkin lymphoma (7.0 vs. 18.9 U.S.) were all lower than U.S. rates. 2). Filipinos living on Guam had high age-adjusted incidence rates for cancers of the nasopharynx (5.1), and liver (9.6). Filipinos had low age-adjusted incidence rates for all cancers (215.7), cancers of the mouth and pharynx when NPC was excluded (4.8), lung and bronchus (35.6 vs. U.S. 70.1), pancreas (1.7 vs. U.S. 11.1), colon-rectum-anus (37.1), female breast (60.7), prostate (46.1), leukemia (4.7), and non-Hodgkin lymphoma (8.4). 3). Micronesians other than Chamorros had the highest age-adjusted incidence rates for cancers of the lung and bronchus (111.5), liver (39.4), and cervix (27.4). Micronesians had low age-adjusted incidence rates for cancers of the colon-rectum-anus (4.1), female breast (35.0), prostate (78.4), leukemia (6.3), and non-Hodgkin lymphoma (6.6). 4). Asians had low total age-adjusted cancer incidence rates (149.7) but had high nasopharyngeal cancer (5.4) and liver (10.7) cancer rates. Asians had low rates of cancers of the mouth and pharynx when nasopharyngeal cancers were excluded (1.4), lung and bronchus cancers (25.8), colon-rectum-anus (26.3), female breast (63.0), ovary (no cases recorded), prostate (31.3), leukemia (5.0) and non-Hodgkin lymphoma (4.9). 5). Caucasians residing on Guam had high age-adjusted cancer incidence rates for cancers of the colon-rectum-anus (91.4), female breast (148.6), ovary (34.7), and leukemia (17.7). Caucasians had low age-adjusted cancer incidence rates for nasopharyngeal cancer (no cases recorded), liver (4.0) and non-Hodgkin lymphoma (7.9). Suggestions are made for further research to explain the ethnic disparities in cancer incidence observed on Guam and to develop strategies for ameliorating these disparities.

**Key Words:** Guam - cancer incidences - ethnic disparities

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### Introduction

The island of Guam, an unincorporated territory of the United States of America, is located in the western Pacific Ocean at longitude 144° 45' E and latitude 13° 30' N. Approximately 1,500 miles east of Manila, Philippines, and a similar distance south of Tokyo, Japan, the island is a multicultural community with no single ethnic group comprising a majority of the population. Although many Guam residents seek medical care "off-island" when they

are seriously ill, especially with cancer, records of persons dying in the continental U.S. and Hawaii who have listed Guam as their usual residence are required to be reported to the Office of Vital Statistics, Guam Department of Public Health and Social Services (GPH). Statistics such as these are included in cancer registry data since the sharing of such information was begun as a nation-wide measure to prevent identity theft. This procedure also serves to record information on persons referred for off-island medical treatment.

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A benchmark review of data collected from Guam death certificates for the 25-year period 1971-1995 suggested that cancer mortality rates on Guam had, in general, increased during this period. Deaths due to cancers of the buccal cavity, liver and pancreas appeared to be particularly frequent on Guam among both sexes while among males deaths due to cancers of the esophagus and respiratory system were also common during this period. Deaths due to melanoma, uterine cancer and prostate cancer appeared to be relatively low on Guam over this time period (Haddock and Naval, 1997).

In part as a result of earlier studies, a Guam Cancer Registry (GCR) was officially established by the Guam Legislature in 1998 but the registry was unfunded and operated solely as a part-time collateral duty of an epidemiologist. In 2003, supported by a grant from the National Cancer Institute of the U.S. National Institutes of Health, the University of Guam and the Cancer Research Center of Hawaii, University of Hawaii, joined forces to establish the Cancer Research Center of Guam. Additional staff hired as a result of this grant enhanced the ability of the registry to collect data on new cancer cases by active surveillance of health care providers, to review patient records to obtain additional information and to periodically contact cancer survivors.

As used in the present study, the term “Chamorro” includes only those identified as of Chamorro ancestry residing on the island of Guam. “Micronesian” includes persons from the Commonwealth of the Northern Mariana Islands (who may also be ethnically Chamorro), the Federated States of Micronesia (Kosrae, Pohnpei, Chuuk, and Yap States), the Republic of the Marshall Islands, and the Republic of Belau. Persons of Chuukese ethnicity constitute approximately 56 % of the Micronesian category population living on the island of Guam. (U.S. Census Bureau, 2002).

## Materials and Methods

Data for the GCR was collected using CanReg4, a software package provided by the International Agency for Research on Cancer, Lyon, France. The data current as of September 2008 was exported to EpiInfo6 software for analysis (Dean et al., 1995). In the year 2000 approximately 38% of Guam’s population was less than 20 years of age compared to 29% of the U.S. population (U.S. Census Bureau, 2002). Because of Guam’s relatively young population, age adjustment was considered appropriate when comparing Guam cancer mortality rates to those of the U.S. The U.S. Year 2000 standard population was used for this age-adjustment (Hoyert and Anderson, 2001).

## Results

### Total cancer

Caucasians living on Guam had the highest overall age-adjusted cancer incidence rate per 100,000 population, more than 22% higher than the US rate. All other ethnic groups with substantial populations on Guam had cancer incidence rates lower than the U.S. rate of 478.6/100,000

population. Total cancer incidence rates of Asians at 149.7 and Filipinos at 215.7 were only 30% and 45%, respectively, of U.S. total rates (see Tables 1).

### Cancers of the mouth and pharynx

Chamorros had the highest age-adjusted incidence rate of mouth and pharynx cancer at 24.4 per 100,000, more than double the US rate of 10.7. The rate among Filipinos at 9.9, Micronesians at 6.3, Asians at 6.9, and Caucasians at 9.6 were all lower than the US rate.

### Nasopharyngeal carcinoma (NPC)

The Chamorro NPC age-adjusted incidence rate of 13.9 was more than 23 times the U.S. rate. The age-adjusted NPC rate for Filipinos and Asians were both more than 8 times the U.S. rate.

### Cancers of the mouth and pharynx (excluding nasopharyngeal cancer)

When nasopharyngeal cancers are excluded, the rate for Chamorro mouth and pharyngeal cancers was still slightly higher than the U.S. rate. Rates for the other ethnic groups were lower than U.S. rates.

### Cancers of the lung and bronchus

Ethnicity-specific age-adjusted lung and bronchus cancer incidence rates were highest for Micronesians (111.5 per 100,000 population), followed by Caucasians (89.6) and Chamorros (75.4), all above the U.S. rate. Filipino (35.6) and Asian (25.8) rates were below the U.S. rate. The U.S. age-adjusted rate for all races was 70.1.

**Table 1. Guam Mean Age-Adjusted Cancer Incidence Rates<sup>1</sup> by Ethnicity for the Period 1998-2002<sup>2</sup> and U.S. Age-Adjusted Cancer Incidence Rates for 2000<sup>3</sup>**

| Site                | Cham <sup>4</sup> | Filip <sup>5</sup> | Micro <sup>6</sup> | Asian | Cauc <sup>7</sup> | US All |
|---------------------|-------------------|--------------------|--------------------|-------|-------------------|--------|
| Population          | 57,295            | 40,729             | 11,094             | 9,600 | 10,509            |        |
| All                 | 406.8             | 215.7              | 401.5              | 149.7 | 585.4             | 478.6  |
| Buccal <sup>8</sup> | 24.4              | 9.9                | 6.3                | 6.9   | 9.6               | 10.7   |
| NPC <sup>9</sup>    | 13.9              | 5.1                | 0.0                | 5.4   | 0.0               | 0.6    |
| Buccal-NPC          | 10.5              | 4.8                | 6.3                | 1.4   | 9.6               | 10.1   |
| Lung <sup>10</sup>  | 75.4              | 35.6               | 111.5              | 25.8  | 89.6              | 70.1   |
| Pancreas            | 12.4              | 1.7                | 4.1                | 12.5  | 17.6              | 11.1   |
| Liver               | 13.2              | 9.6                | 39.4               | 10.7  | 4.0               | 5.2    |
| Colon <sup>11</sup> | 44.3              | 37.1               | 4.1                | 26.3  | 91.4              | 56.9   |
| Breast (f)          | 115.9             | 60.7               | 35.0               | 63.0  | 148.6             | 130.9  |
| Cervix              | 16.2              | 8.4                | 27.4               | 8.5   | 10.5              | 9.6    |
| Ovary               | 7.0               | 10.6               | 17.0               | 0.0   | 34.7              | 14.2   |
| Prostate            | 103.9             | 46.1               | 78.4               | 31.3  | 88.1              | 167.7  |
| Leukemia            | 11.0              | 4.7                | 6.3                | 5.0   | 17.7              | 12.6   |
| NHL <sup>12</sup>   | 7.0               | 8.4                | 6.6                | 4.9   | 7.9               | 18.9   |

<sup>1</sup>Rate is expressed as average annual number of cases per 100,000 population age-adjusted to the U.S. 2000 standard population; <sup>2</sup>Guam Cancer Registry, Cancer Research Center of Guam, University of Guam. Data current as of 9/12/2008; <sup>3</sup>U.S. Cancer Statistics Working Group. United States Cancer Statistics: 1999-2004 Incidence and Mortality Web-based Report. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute; 2007, Available at: [www.cdc.gov/uscs](http://www.cdc.gov/uscs); <sup>4</sup>Chamorroan; <sup>5</sup>Filipino; <sup>6</sup>“Micronesian” includes persons of Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Republic of the Marshall Islands and Republic of Belau ancestry; <sup>7</sup>Caucasian; <sup>8</sup>Mouth and pharynx; <sup>9</sup>Nasopharyngeal; <sup>10</sup>Lung and bronchus; <sup>11</sup>Colon, rectum and anus; <sup>12</sup>Non-Hodkin lymphoma

#### *Pancreatic cancer*

Caucasians had the highest age-adjusted incidence rate of pancreatic cancer of all the major ethnic groups living on Guam at 17.6 per 100,000 population, followed by Asians (12.5) and Chamorros (12.4), all above the U.S. age-adjusted incidence rate for all races of 11.1. Micronesians (4.1) and Filipinos (1.7) had rates lower than the U.S. average.

#### *Liver cancer*

Age-adjusted liver cancer incidence rates were higher than the U.S. rate for all ethnicities except Caucasian. Rates are highest for Micronesians (at 39.4 was more than 7.5 times the U.S. average), followed by Chamorros (13.2), Asians (10.7), and Filipinos (9.6). The U.S. age-adjusted rate of liver cancer for all races was 5.2.

#### *Colon-rectum-anus cancer*

Caucasians had the highest age-adjusted colon cancer incidence rate among Guam residents at 91.4 per 100,000, 61% higher than the U.S. rate of 56.9. All other ethnicities had colon cancer rates lower than the U.S. average with Micronesians having an especially low rate of 4.1, only 7% of the U.S. average.

#### *Breast cancer*

During the period studied, breast cancer was the leading cause of cancer in women living on Guam (201 cases vs. 62 cases of lung & bronchus cancer and 44 cases of colon cancer). Caucasian women had the highest age-adjusted incidence rate at 148.6 per 100,000 which was 14% higher than the average U.S. rate of 130.9. Chamorro women at 115.9, Asian women at 63.0, Filipinas at 60.7 and Micronesian women at 35.0 all had lower rates than the U.S. average.

#### *Cervical cancer*

Micronesians had the highest age-adjusted cervical cancer incidence rates on Guam, at 27.4 almost 3 times the U.S. rate of 9.6. Chamorros (16.2) and Caucasians (10.5) on Guam also had higher rates than the U.S. average while Asians (8.5) and Filipinas (8.4) had slightly lower rates during the period studied.

#### *Ovarian cancer*

Caucasian women residing on Guam had especially high age-adjusted ovarian cancer incidence rates (34.7), the Micronesian women's rate of 17.0 was slightly higher than the U.S. women's rate of 14.2 while Filipinas (10.6), Chamorros (7.0) and Asians (no cases recorded) had rates lower than that of U.S. women.

#### *Prostate cancer*

Prostate cancer incidence was significantly lower on Guam for all ethnicities than the U.S. average of 167.7. Chamorro males had the highest age-adjusted rate of prostate cancer incidence rate on Guam at 103.9 per 100,000, followed by Caucasians at 88.1, Micronesians at 78.4, Filipinos at 46.1 and Asians at 31.3.

#### *Leukemia*

Caucasians had the highest age-adjusted leukemia incidence rate at 17.7 cases per 100,000 population and they were the only group above the U.S. benchmark. Chamorros at 11.0, Micronesians at 6.3, Asians at 5.0 and Filipinos at 4.7 were all below the U.S. average age-adjusted rate of 12.6.

#### *Non-Hodgkin lymphoma*

Filipinos had the highest Guam age-adjusted Non-Hodgkin lymphoma incidence rates at 8.4 per 100,000 population but all ethnic groups studied had rates much lower than the U.S. average of 18.9.

## **Discussion**

All deaths that occur on Guam are certified and all death certificates are completed by an attending physician or a Medical Examiner. Data on Guam cancer deaths has therefore been assumed to be less ephemeral than Guam cancer incidence data and was described in an earlier paper (Haddock et al., 2006). Subsequent assistance from the NIH grant has permitted intensive review of hospital discharge data and clinic patient records as far back as 1998 and is the basis for the cancer incidence data presented in this article.

A comparison of ethnicity-specific age-adjusted cancer incidence and mortality rankings revealed that Chamorro and Asian ethnic groups each ranked higher for total cancer mortality rate than their ranking for total cancer incidence rate and that the same relationship existed for four additional but different specific cancers (Table 2). This suggests that on Guam these ethnic groups have less access to appropriate health care services – for example; diagnosis of cancer at a later stage of their illness, less effective treatment, etc. A recent paper reports a similar conclusion with respect to access to prenatal care for Chamorro and Micronesian women (Haddock et al., 2008).

Because of the relatively small population numbers dealt with in this study, it is possible that certain of the data presented may not be statistically significant even when aggregated for a 5-year period. Cancer rates for African-Americans living on Guam were not calculated because of their very small population (1,618 in 2000). Nevertheless some broad conclusions may be reached regarding the presence of cancer incidence disparities among the major ethnic populations represented on Guam. This report may suggest not only areas for fruitful future research but information on those ethnic groups to whom specific cancer awareness, prevention and outreach programs should be directed.

There have been several hypotheses suggested concerning particular cancers and the reasons for their high incidence on Guam. For example, an early study which correlated the presence of pre-cancerous oral lesions and self-reported tobacco, alcohol and betel nut use concluded that on Guam the risk of developing oral cancer associated with betel nut use was about the same as the risk associated with tobacco use (Haddock et al., 1981).

The high incidence of combined “mouth and pharynx”

**Table 2. Comparison of Guam Mean Age-Adjusted Cancer Incidence and Mortality Rate Rankings by Ethnicity for the Period 1998-2002**

| Site                              | Chamorro | Filipino | Micro* | Asian | Cauc** |
|-----------------------------------|----------|----------|--------|-------|--------|
| <b>All Cancers</b>                |          |          |        |       |        |
| Incidence                         | ++++     | ++       | +++    | +     | +++++  |
| Mortality                         | +++++    | +        | +++    | ++    | ++++   |
| <b>Buccal (Mouth +Pharynx)</b>    |          |          |        |       |        |
| Incidence                         | +++++    | ++++     | +      | ++    | +++    |
| Mortality                         | +++++    | ++       | ++++   | +++   | +      |
| <b>Nasopharyngeal</b>             |          |          |        |       |        |
| Incidence                         | +++++    | +++      | --     | ++++  | --     |
| Mortality                         | +++++    | +++      | --     | ++++  | --     |
| <b>Buccal less Nasopharyngeal</b> |          |          |        |       |        |
| Incidence                         | +++++    | ++       | +++    | +     | ++++   |
| Mortality                         | +++++    | ++       | ++++   | --    | +++    |
| <b>Lung and Bronchus</b>          |          |          |        |       |        |
| Incidence                         | +++      | ++       | +++++  | +     | ++++   |
| Mortality                         | +++++    | ++       | ++++   | +     | +++    |
| <b>Pancreas</b>                   |          |          |        |       |        |
| Incidence                         | +++      | +        | ++     | ++++  | +++++  |
| Mortality                         | +++      | ++       | --     | +++++ | ++++   |
| <b>Liver</b>                      |          |          |        |       |        |
| Incidence                         | ++++     | ++       | +++++  | +++   | +      |
| Mortality                         | ++++     | ++       | +++++  | +++   | --     |
| <b>Colorectal-Anus</b>            |          |          |        |       |        |
| Incidence                         | ++++     | +++      | +      | ++    | +++++  |
| Mortality                         | +++++    | +++      | --     | ++    | ++++   |
| <b>Breast (female)</b>            |          |          |        |       |        |
| Incidence                         | ++++     | ++       | +      | +++   | +++++  |
| Mortality                         | +++++    | +        | ++     | +++   | ++++   |
| <b>Cervix</b>                     |          |          |        |       |        |
| Incidence                         | ++++     | +        | +++++  | ++    | +++    |
| Mortality                         | +++      | ++       | --     | +++++ | ++++   |
| <b>Prostate</b>                   |          |          |        |       |        |
| Incidence                         | +++++    | ++       | +++    | +     | ++++   |
| Mortality                         | +++++    | ++       | --     | +++   | ++++   |
| <b>Leukemia</b>                   |          |          |        |       |        |
| Incidence                         | ++++     | +        | +++    | ++    | +++++  |
| Mortality                         | ++++     | +++      | ++     | +     | +++++  |
| <b>Non-Hodkin Lymphoma</b>        |          |          |        |       |        |
| Incidence                         | +++      | +++++    | --     | ++    | ++++   |
| Mortality                         | ++++     | +++      | ++     | +     | +++++  |

Note: +++++ = highest rank of 5 ethnic groups, -- = no cases recorded; \*Micronesian; \*\*Caucasian

cancers among Chamorros is attributed primarily to the extremely high incidence of nasopharyngeal cancer (NPC) in this population. Similarly, the incidence rate for cancers of the mouth and pharynx among Asians and Filipinos is low when cancers of the nasopharynx are excluded. Nasopharyngeal carcinoma is known to occur with high incidence in certain populations of southern China, southeastern Asia, northern and eastern Africa and American Samoa as well as Guam (Mishra et al., 1996; Heyman, 2004) and the epidemiology of NPC has been shown to be multi-factorial with genetic, infectious, dietary and environmental components (Heyman, 2004; Loh et al., 2006; Li et al., 2006). In addition, the Chinese had extensive trade relations with many Pacific cultures before these islands were "discovered" by Europeans. As the spread of leprosy through out the Pacific has been attributed to this trade, it is possible susceptibility to nasopharyngeal cancer may have been spread in the same

manner (Akeli, 2007). In a positive development, the association of NPC with the Epstein-Barr virus presents the possibility of eventually developing a protective vaccine (Loh et al., 2006).

The National Cancer Institute's Center to Reduce Cancer Health Disparities asserts that high rates of death due to cervical cancer may be interpreted as one indicator of health system problems such as poor infrastructure, lack of access, lack of culturally competent communication and patient/provider education deficits (Freeman and Wingrove, 2005). In addition to recent developments in the prevention of cervical cancer through vaccination (Riezebos-Brilman, 2006), the appropriateness of current cancer prevention and awareness programs are clearly in need of reevaluation and reforming with cultural sensitivity for use among Pacific Island cultures. Outreach efforts should be directed towards helping the communities most affected to develop a sense of ownership and empowerment in their ability to prevent cervical cancer (Fouad et al., 2006)

A high prevalence of hepatitis B antigenemia among Micronesians has been documented and the high prevalence of liver cancer among several of the ethnic groups residing on Guam is apparently related (Withers et al., 1994). The initiation of universal hepatitis B vaccination of Guam newborns in 1991 should eventually result in decreased rates of chronic hepatitis B as well as a decreased incidence of primary liver cancer, at least among persons born on Guam. Those records will be available in the Guam Cancer Registry as the population born after 1991 matures.

A high proportion of Caucasians residing on Guam are associated with U.S. military forces (active duty military, military dependents, civil service employees working on military bases, etc.). It has been suggested that the relatively high rates of leukemia and non-Hodgkin's lymphoma observed among this ethnic group may be related to their participation and exposure to environmental factors related to military activities. This hypothesis requires further investigation and is a good example of a study that could provide useful information to Guam residents about cancer and its causes.

While the data utilized in this study were derived from a relatively small population base and over a relatively short period of time, the trends observed provide valuable direction for future cancer research, education, outreach, prevention and control efforts on Guam. While perhaps not definitive, the results of comparing cancer mortality rates with cancer incidence rates suggest that there is a need for future cancer awareness, education and outreach efforts on Guam tailored to reach specific target populations.

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## References

- Akeli S (2007). Leprosy in Samoa 1890 to 1922: Race, Colonial Politics and Disempowerment. A thesis submitted in fulfillment of the requirements for the Degree of Master of Arts in History at the University of Canterbury.
- Dean AG, Dean JA, Coulombier D, Brendel KA, et al. (2001). Epi Info, Version 6.04d: A Word-Processing, Database, and Statistics Program for Public Health on IBM-compatible Microcomputers. Centers for Disease Control and Prevention, Atlanta, Georgia.
- Fouad MN, Partridge E, Dignan M, et al (2006). A community-driven action plan to eliminate breast and cervical cancer disparity: successes and limitations. *J Cancer Educ*, **21** (1 Suppl), S91-100.
- Freeman, HP, Wingrove BK (eds) (2005). Excess Cervical Cancer Mortality: A Marker for Low Access to Health Care in Poor Communities. Rockville, MD: National Cancer Institute, Center to Reduce Cancer Health Disparities. NIH Pub. No. 05-5282.
- Haddock RL, Hoffman JH, Williams WR (1981). Betel nut chewing on Guam. *Fiji Med J*, 139-145.
- Haddock RL, Naval CL (1997). Cancer in Guam: a review of death certificates from 1971-1995. *Pacific Health Dialog*, **4**, 66-75.
- Haddock RL, Talon RJ, Whippy HJ (2006). Ethnic disparities in cancer mortality among residents of Guam. *Asian Pac J Cancer Prev*, **7**, 411-4.
- Haddock RL, Murphy-Bell M, Naval CL, Garrido C (2008). Lack of pre-natal care – a re-emerging health problem on Guam. *Hawai'i J Public Health*, **1**, 40-4.
- Heyman DL (ed) (2004). Control of Communicable Diseases Manual, 18th edition. American Public Health Association, Washington p343.
- Hoyert DL, Anderson RN (2001). Age-adjusted death rates: Trend data based on the year 2000 standard population. National vital statistics reports 49(9). National Center for Health Statistics, Hyattsville, Maryland, USA.
- Loh KS, Goh BC, Lu J, et al. (2006). Familial nasopharyngeal carcinoma in a cohort of 200 patients. *Arch Otolaryngol Head Neck Surg*, **132**, 82-5.
- Mishra SI, Luce-Aorlua P, Wilkens LR, Bernstein L (1996). Cancer among American-Samoans: site-specific incidence in California and Hawaii. *Int J Epidemiol*, **25**, 713-21.
- Riezebos-Brilman A, de Mare A, Bungener L, et al (2006). Recombinant alphaviruses as vectors for anti-tumor and antimicrobial immunotherapy. *J Clin Virol*, **35**, 233-43.
- Tseng C-W, Omphroy G, Cruz L, Naval CL, Haddock RL (2004). Cancer in the Territory of Guam. *Pacific Health Dialog*, **11**, 57- 63.
- Li W, Ray RM, Gao DL, et al (2006). Occupational risk factors for nasopharyngeal cancer among female textile workers in Shanghai, China. *Occup Environ Med*, **63**, 39-44.
- U.S. Census Bureau (2002). Population and Housing Profile, 2000 Census of Population and Housing, Guam. U.S. Dept of Commerce, Washington, D.C.
- U.S. Cancer Statistics Working Group. United States Cancer Statistics:1999–2004.Incidence and Mortality Web-based Report. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute; 2007. Available at: <http://apps.nccdc.dcd.gov/uscs/Table.aspx?Group=TableAll&Year=2000&Display=n>
- Withers BG, Kelley PW, Pang LW, et al (1994). Vaccine-preventable disease susceptibility in a young adult Micronesian population. *Southeast Asian J Trop Med Public Health*, **25**, 569-74.

