美国癌症发病率的种族和性别差异分析(1992–2005)

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摘要：在世界范围内，癌症是人类最大的死因之一，癌症发病率也呈逐年上升趋势。癌症的发病率在不同种族和不同性别中存在差别。本文分析了 1992-2005 年中美国 13 个全人群癌症登记中心的数据，描述和对比了各种癌症在不同种族和不同性别中的发病趋势。结果表明，前列腺癌是男性中发病率最高的癌症，乳腺癌是女性中发病率最高的癌症，肺及支气管癌在两种性别中均名列第二。对于大部分癌症类型来说，白色人种或黑色人种中的发病率最高；对于胃癌，肝癌和甲状腺癌来说，黄色人种(包括亚裔和太平洋岛屿居民)中的发病率最高；对于肝内胆管癌和胆囊癌来说，美洲土著(包括印第安人和阿拉斯加人)中的发病率最高。男性比女性更容易患大部分类型的癌症，而女性比男性更容易患甲状腺癌和胆囊癌。在所有种族和性别的人群中，肝癌和甲状腺癌的发病率在此 14 年间呈上升趋势。

关键词：癌症；发病率；率比；种族；性别

Cancer Incidence Patterns by Race and Sex in the United States, 1992-2005

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ABSTRACT: Cancer is a leading cause of death worldwide and the cancer incidence is increasing. Variations in cancer incidence patterns have been observed through different ethnicities as well as between males and females. Data from 13 U.S. population-based cancer registries during 1992-2005 were analyzed and the incidence patterns were presented for different types of cancer by race and sex. Prostate cancer and breast cancer were identified with the highest incidence rates in males and females respectively among all race groups, and lung and bronchus cancer listed second. Being a white or a black increased the risk of most types of cancers, with exception of stomach cancer, liver cancer and thyroid cancer of which being an Asian increases the risk, and intrahepatic bile duct cancer and gallbladder cancer of which being a native American increases the risk. Being a male increased the risk of most types of cancers among all race groups, with the exception of thyroid cancer and gallbladder cancer. The incidence rate of liver cancer and thyroid cancer kept increasing during the 14 years among both sexes and all race groups.

Key words: Cancer; Incidence; Rate ratio; Race; Sex

Cancer is a leading cause of death worldwide. It accounted for 7.9 million deaths (around 13% of all deaths) in 2007[1]. The causes of most types of cancers are largely unknown. Cancer was proposed to be a disease of civilization by previous anthropologists[2], which signifies the roles of the environment and lifestyles in cancer development. Since James Watson and Francis Crick discovered the chemical structure of DNA, scientists have learned that it was the damage to DNA by chemicals, radiations or viruses that often resulted in the development of cancer, which led to the recognition and understanding of the importance of genetic susceptibility. The modern cancer etiology theory believes that both the environmental exposures and genetic susceptibility and the interaction between them cause the development of cancer[3,4]. However, the partition of each risk factor in different cancer types is still a mystery. Variations in cancer incidence patterns have been observed through different ethnicities as

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well as different sexes. A comparison of the variations may provide insight to the gene-environment components of different cancers, and further a better strategy for cancer prevention. This article presents the incidence patterns of different cancer types by race and sex using data collected from 13 U.S. population-based cancer registries during 1992-2005.

Materials and Methods

Incidence data were obtained from the United States National Cancer Institute's Surveillance, Epidemiology, and End results (SEER) Program. SEER data collection began in the early 1970s with nine population-based registries (Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, and Utah). SEER expanded in 1992 to include four additional registries (Los Angeles, San Jose-Monterey, Rural Georgia, and the Alaska Native Tumor Registry). SEER further expanded to include additional four registries (Greater California, Kentucky, Louisiana, and New Jersey) since 2001[5]. This article used the most recently available complete dataset which was submitted on November 2007[6]. The dataset includes the cases diagnosed between 1 January 1992 and 31 December 2005 identified from the thirteen cancer registries, which cover approximately 14% of the U.S. population[7].

For each identified case, SEER registries report patient demographic data such as age at diagnosis, race/ethnicity and sex; tumor information such as primary site; reporting source, and follow-up information. Cases were grouped into four race groups: whites, blacks, American Indian/Alaska Native (Native) and Asian/Pacific Islander (Asian) which specifically includes Asian Indians/Pakistanis, Chinese, Filipinos, Guamanians, Native Hawaiians, Japanese, Kampucheans, Koreans, Laotians, Samoans, Tongans, and Vietnamese.

Age-adjusted incidence rate for 80 cancer types in 19 broad categories were calculated by race and sex, using the 2000 US population as standard population. Rate ratios (RR) of other races compared to whites were calculated among both sexes and totals and presented for 33 common cancers. Rate ratios of males compared to females were calculated among four race groups and presented for 26 common cancers. Principle component analyses were conducted for race and sex groups using incidence rates of 80 cancers with and without cancers on breast and genital systems respectively, as well as for cancer types using incidence rates of eight race/sex populations. The average annual percent change (APC) over 1992-2005 were calculated and presented for both sexes. APC is used to measure trends or change in rates over time. The APC is calculated by fitting a least squares regression line to the natural logarithm of the rates, using the calendar year as a regressor variable[8]. SEER*Stat 6.4.4 was used in incidence rate calculation, and SPSS 13.0 was used in principle component analyses.

Results

As shown in Table 1, during 1992-2005, the following cancers had the highest incidence rates among all race groups: prostate, breast, lung and bronchus, urinary bladder, kidney and renal pelvis, sigmoid colon, and pancreas. Melanoma of the skin and non-Hodgkin lymphoma in whites, stomach cancer in other race groups than whites, and liver cancer in Asians are also prominently high. Prostate cancer and lung and bronchus cancer are the top two cancers for males through all race groups; breast cancer and lung and bronchus cancer are the top two cancers for females through all race groups.

As shown in Figure 1, among all race groups, whites had the highest risk for the following cancer types: melanoma of the skin, breast, corpus uteri, ovary, testis, urinary bladder, ureter, eye and orbit, brain, Hodgkin lymphoma, non-Hodgkin lymphoma, acute lymphocytic leukemia, chronic lymphocytic leukemia, myeloid and monocytic leukemia, and mesothelioma; blacks had the highest risk for the following cancer types: oral cavity and pharynx, esophagus, small intestine, colon,

Tab. 1 Cancer Age-adjusted Incidence Rates, 13 SEER Registries, 1992-2005

表 1 美国 13 个 SEER 癌症登记中心的年龄校正发病率 1992–2005

	White 白人			Black 黑人			Native* 美洲土著*			Asian* 黄人*		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
All Sites	480.62	566.71	424.22	521.85	700.01	403.43	276.17	307.89	255.37	334.95	386.48	299.70
Oral Cavity and Pharynx	10.83	16.00	6.53	12.11	19.51	6.49	7.61	11.17	4.69	8.68	12.24	5.73
Lip	1.16	2.12	0.43	0.14	0.18	0.13	0.42	0.86	0.06	0.09	0.08	0.10
Tongue	2.73	3.95	1.66	2.67	4.41	1.36	1.20	1.41	0.96	1.76	2.25	1.35
Salivary Gland	1.25	1.67	0.97	0.99	1.18	0.87	0.78	0.93	0.72	0.94	1.02	0.88
Floor of Mouth	0.86	1.25	0.51	1.13	1.89	0.54	0.77	0.98	0.62	0.30	0.41	0.21
Gum and Other Mouth	1.71	1.99	1.46	2.03	2.89	1.39	0.86	1.15	0.60	1.09	1.31	0.92
Nasopharynx	0.40	0.57	0.25	0.67	1.06	0.37	1.92	2.80	1.18	3.17	4.74	1.81
Tonsil	1.35	2.19	0.59	1.81	3.16	0.76	0.62	1.11	0.20	0.60	0.99	0.27
Oropharynx	0.30	0.48	0.15	0.64	1.13	0.26	0.15	0.24	0.07	0.11	0.17	0.05
Hypopharynx	0.80	1.35	0.34	1.51	2.80	0.55	0.76	1.41	0.25	0.56	1.11	0.12
Other Oral Cavity and Pharynx	0.28	0.43	0.16	0.50	0.82	0.27	0.13	0.28	0.03	0.08	0.16	0.02
Digestive System	87.36	107.33	71.95	114.46	141.36	95.60	77.73	90.39	67.58	94.82	120.68	74.38
Esophagus	4.41	7.52	1.95	7.12	11.51	3.95	3.55	6.11	1.58	2.80	4.94	1.11
Stomach	7.58	10.99	5.04	13.20	18.92	9.34	10.81	14.83	7.68	16.55	22.13	12.27
Small Intestine	1.67	2.02	1.41	2.98	3.66	2.52	1.08	1.26	0.93	1.02	1.34	0.77
Colon and Rectum	52.18	61.84	44.83	62.24	72.54	55.52	38.32	42.38	34.95	45.55	54.75	38.37
Colon excluding Rectum	37.86	43.42	33.69	48.08	54.62	43.99	27.85	29.61	26.41	30.88	35.46	27.37
Cecum	8.96	9.50	8.54	11.92	12.65	11.45	6.00	5.20	6.56	4.82	4.91	4.75
Appendix	0.49	0.51	0.47	0.49	0.53	0.48	0.11	0.09	0.12	0.29	0.27	0.30
Ascending Colon	6.14	6.67	5.74	8.01	8.84	7.54	3.64	3.55	3.71	4.51	4.60	4.43
Hepatic Flexure	2.13	2.50	1.87	2.42	2.78	2.19	1.79	1.76	1.85	1.71	2.00	1.48
Transverse Colon	3.48	3.79	3.24	4.31	4.94	3.99	2.65	2.48	2.72	2.71	2.97	2.50
Splenic Flexure	1.36	1.73	1.08	2.38	3.01	1.97	0.97	1.21	0.82	1.07	1.35	0.86
Descending Colon	2.17	2.71	1.77	3.54	4.29	3.10	1.14	1.19	1.06	2.45	3.06	1.99
Sigmoid Colon	11.15	13.78	9.20	11.98	13.96	10.65	10.19	12.73	8.28	12.15	14.89	10.07
Large Intestine, NOS	1.99	2.23	1.76	3.02	3.62	2.61	1.37	1.40	1.29	1.18	1.42	0.99
Rectum and Rectosigmoid Junction	14.33	18.42	11.14	14.16	17.92	11.52	10.47	12.77	8.54	14.67	19.29	11.01
Rectosigmoid Junction	4.49	5.66	3.59	4.55	5.69	3.76	2.80	3.12	2.48	4.51	5.94	3.38
Rectum	9.83	12.76	7.55	9.61	12.23	7.76	7.66	9.65	6.06	10.16	13.34	7.63
Anus, Anal Canal and Anorectum	1.44	1.28	1.57	1.59	1.78	1.41	0.91	0.84	0.95	0.53	0.51	0.55
Liver and Intrahepatic Bile Duct	4.77	7.25	2.73	7.26	11.74	3.85	8.01	10.24	6.21	14.03	21.19	8.12
Liver	4.02	6.33	2.12	6.70	11.01	3.40	6.62	8.68	4.94	12.88	19.85	7.13
Intrahepatic Bile Duct	0.75	0.92	0.62	0.57	0.73	0.45	1.40	1.56	1.27	1.15	1.34	0.99
Gallbladder	1.21	0.78	1.54	1.29	0.81	1.58	3.49	2.80	4.06	1.56	1.40	1.69
Other Biliary	1.55	1.93	1.28	1.39	1.83	1.12	2.19	2.15	2.22	2.30	2.74	1.95
Pancreas	11.04	12.59	9.76	16.04	17.50	14.77	8.23	8.92	7.67	9.36	10.78	8.26
Retroperitoneum	0.43	0.48	0.40	0.43	0.37	0.49	0.15	0.19	0.13	0.39	0.37	0.40
Peritoneum, Omentum and Mesentery	0.59	0.09	1.00	0.33	0.09	0.50	0.24	0.02	0.41	0.32	0.07	0.51
Other Digestive Organs	0.49	0.57	0.43	0.58	0.62	0.55	0.74	0.65	0.78	0.43	0.48	0.39
Respiratory System	67.50	87.13	53.33	87.36	131.27	57.39	42.60	56.24	31.99	44.95	64.62	29.69
Nose, Nasal Cavity and Middle Ear	0.69	0.87	0.55	0.73	0.99	0.54	0.81	1.17	0.52	0.63	0.83	0.46
Larynx	3.82	6.78	1.44	6.35	11.90	2.34	1.63	2.85	0.59	1.67	3.31	0.39
Lung and Bronchus	62.75	79.12	51.19	80.04	118.05	54.32	40.02	52.02	30.78	42.45	60.18	28.74
Pleura	0.03	0.05	0.02	0.03	0.04	0.03	0.02	0.04	0.00	0.02	0.04	0.01
Trachea, Mediastinum and Other Respiratory Organs	0.21	0.31	0.13	0.22	0.29	0.15	0.13	0.15	0.10	0.18	0.27	0.09
Bones and Joints	0.95	1.08	0.82	0.75	0.84	0.68	0.64	0.66	0.63	0.61	0.69	0.53
Soft Tissue including Heart	2.93	3.57	2.45	3.02	3.43	2.70	1.55	1.79	1.38	2.18	2.59	1.84
Skin excluding Basal and Squamous	22.21	28.00	18.21	2.14	2.44	1.96	3.28	3.86	2.84	2.23	2.44	2.07
Melanoma of the Skin	20.30	25.41	16.74	0.95	1.18	0.81	2.65	3.22	2.20	1.38	1.48	1.32
Other Non-Epithelial Skin	1.91	2.59	1.47	1.19	1.25	1.15	0.63	0.63	0.64	0.84	0.96	0.75
Breast	73.79	1.16	135.99	69.40	1.66	120.30	36.59	0.19	67.85	50.59	0.58	92.64
Female Genital System	28.70	0.00	53.31	25.88	0.00	44.95	17.08	0.00	31.54	21.23	0.00	39.13
Cervix Uteri	4.57	0.00	8.94	6.73	0.00	11.95	3.97	0.00	7.47	5.21	0.00	9.65
Corpus and Uterus, NOS	13.95	0.00	25.74	10.95	0.00	18.89	6.43	0.00	11.90	9.34	0.00	17.20
Corpus Uteri	13.71	0.00	25.32	10.44	0.00	18.03	6.15	0.00	11.43	9.14	0.00	16.85
Uterus, NOS	0.24	0.00	0.42	0.51	0.00	0.86	0.28	0.00	0.47	0.20	0.00	0.35
Ovary	8.06	0.00	14.84	6.06	0.00	10.43	5.26	0.00	9.65	5.61	0.00	10.33
Vagina	0.39	0.00	0.69	0.66	0.00	1.12	0.41	0.00	0.72	0.29	0.00	0.53
Vulva	1.33	0.00	2.35	1.07	0.00	1.85	0.72	0.00	1.28	0.49	0.00	0.87
Other Female Genital Organs	0.41	0.00	0.75	0.41	0.00	0.72	0.28	0.00	0.52	0.29	0.00	0.54
Male Genital System	78.36	178.81	0.00	113.47	278.12	0.00	32.19	73.70	0.00	45.67	104.90	0.00
Prostate	74.78	171.61	0.00	112.41	275.66	0.00	30.24	69.64	0.00	44.34	102.07	0.00
Testis	3.12	6.11	0.00	0.59	1.26	0.00	1.49	2.98	0.00	0.94	1.94	0.00
Penis	0.34	0.80	0.00	0.36	0.93	0.00	0.38	0.90	0.00	0.17	0.38	0.00
Other Male Genital Organs	0.13	0.29	0.00	0.11	0.26	0.00	0.07	0.18	0.00	0.22	0.51	0.00
Urinary System	35.23	57.78	18.65	27.06	41.15	17.51	18.76	28.18	11.41	16.81	26.61	9.21
Urinary Bladder	22.47	39.95	9.90	12.73	20.70	7.57	5.79	10.30	2.30	9.67	16.65	4.31
Kidney and Renal Pelvis	11.89	16.45	8.24	13.50	19.29	9.31	12.67	17.43	8.91	6.45	9.09	4.35
Ureter	0.57	0.85	0.37	0.27	0.38	0.19	0.23	0.31	0.17	0.51	0.62	0.41
Other Urinary Organs	0.30	0.53	0.14	0.57	0.78	0.44	0.07	0.13	0.03	0.19	0.24	0.14
Eye and Orbit	0.92	1.12	0.77	0.23	0.24	0.22	0.33	0.44	0.23	0.24	0.25	0.22
Brain and Other Nervous System	7.11	8.44	5.97	4.10	4.76	3.58	2.81	3.72	2.12	3.51	4.02	3.08
Brain	6.69	8.00	5.58	3.63	4.33	3.09	2.52	3.42	1.84	3.21	3.73	2.78
Cranial Nerves Other Nervous System	0.42	0.44	0.40	0.47	0.43	0.49	0.29	0.29	0.28	0.30	0.29	0.30
Endocrine System	8.40	4.93	11.89	5.17	3.16	6.86	5.01	3.18	6.85	9.04	4.86	12.81
Thyroid	7.76	4.19	11.35	4.43	2.34	6.18	4.67	2.60	6.73	8.23	3.88	12.15
Other Endocrine including Thymus	0.64	0.74	0.54	0.74	0.82	0.68	0.34	0.58	0.12	0.81	0.98	0.66
Lymphoma	23.42	28.40	19.32	17.30	21.90	13.68	9.75	11.38	8.44	14.72	17.87	12.22
Hodgkin Lymphoma	2.95	3.30	2.65	2.49	2.86	2.19	0.77	0.85	0.73	1.10	1.27	0.95
Hodgkin - Nodal	2.88	3.21	2.58	2.42	2.78	2.14	0.77	0.85	0.73	1.06	1.22	0.91
Hodgkin - Extranodal	0.07	0.08	0.07	0.06	0.07	0.05	0.00	0.00	0.00	0.04	0.05	0.04
Non-Hodgkin Lymphoma	20.47	25.10	16.67	14.81	19.04	11.49	8.98	10.53	7.71	13.62	16.60	11.27
NHL - Nodal	13.89	16.95	11.40	9.59	12.46	7.36	5.34	5.84	4.88	7.81	9.64	6.36
NHL - Extranodal	6.58	8.15	5.27	5.22	6.58	4.13	3.65	4.69	2.84	5.81	6.96	4.91
Myeloma	5.36	6.82	4.29	11.64	13.78	10.26	4.25	4.44	4.10	3.44	4.19	2.87
Leukemia	13.39	17.60	10.24	10.27	13.14	8.27	5.40	6.01	4.81	7.75	9.71	6.19
Lymphocytic Leukemia	6.66	9.01	4.83	4.34	5.85	3.27	2.38	2.50	2.19	2.39	3.08	1.81
Acute Lymphocytic Leukemia	1.65	1.89	1.41	0.84	0.90	0.77	1.11	1.17	1.02	1.31	1.51	1.13
Chronic Lymphocytic Leukemia	4.49	6.30	3.16	3.22	4.49	2.34	1.18	1.22	1.09	0.89	1.27	0.59
Other Lymphocytic Leukemia	0.51	0.81	0.25	0.28	0.46	0.16	0.09	0.10	0.08	0.19	0.30	0.10
Myeloid and Monocytic Leukemia	5.88	7.48	4.73	5.08	6.21	4.31	2.75	3.17	2.40	4.73	5.88	3.84
Acute Myeloid Leukemia	3.70	4.62	3.07	3.14	3.69	2.80	1.85	2.25	1.53	3.19	3.85	2.70
Acute Monocytic Leukemia	0.27	0.35	0.21	0.15	0.16	0.15	0.08	0.09	0.08	0.23	0.29	0.17
Chronic Myeloid Leukemia	1.73	2.28	1.32	1.57	2.15	1.15	0.80	0.82	0.75	1.21	1.62	0.88
Other Myeloid/Monocytic Leukemia	0.17	0.23	0.13	0.21	0.21	0.20	0.02	0.00	0.03	0.10	0.12	0.09
Other Leukemia	0.85	1.12	0.68	0.85	1.09	0.69	0.28	0.33	0.22	0.63	0.75	0.54
Other Acute Leukemia	0.44	0.59	0.35	0.39	0.55	0.29	0.11	0.16	0.08	0.31	0.33	0.29
Aleukemic, Subleukemic and NOS	0.41	0.53	0.33	0.46	0.54	0.41	0.16	0.18	0.15	0.32	0.42	0.26
Mesothelioma	1.16	2.17	0.44	0.61	1.15	0.27	0.75	1.10	0.46	0.39	0.68	0.16
Kaposi Sarcoma	1.96	3.79	0.13	2.82	5.74	0.29	0.98	2.01	0.00	0.47	0.93	0.05
Miscellaneous	11.05	12.56	9.91	14.07	16.34	12.42	8.85	9.43	8.45	7.64	8.61	6.87

Rates are per 100,000 and age-adjusted to the 2000 US Std Population (single ages to 84 - Census P25-1130) standard.

*Native is abbreviated for American Indian/Alaska Native; Asian is abbreviated for Asian/Pacific Islander .

发病率单位为 /100, 000；年龄校正运用 2000 美国标准人群。*美洲土著包括印第安人和阿拉斯加人；黄人包括亚裔和太平洋岛屿居民。

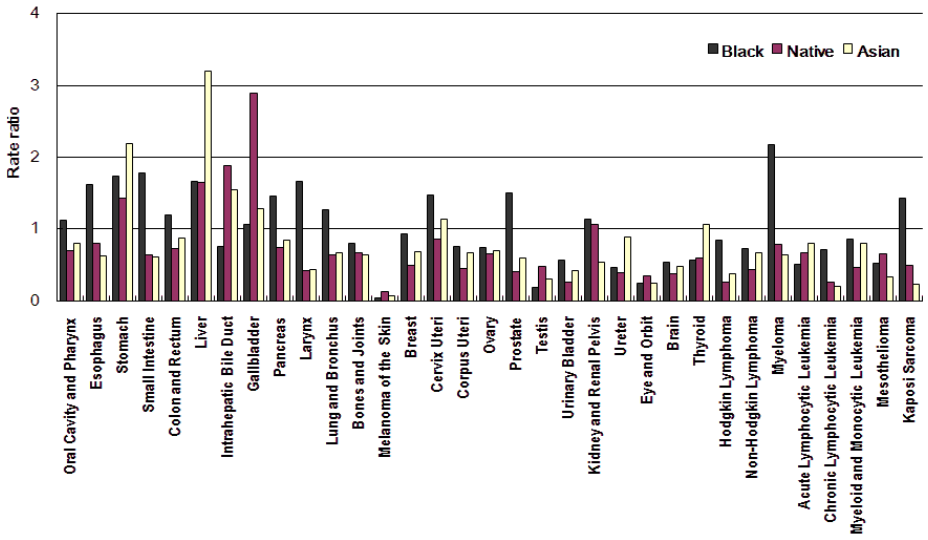

Fig. 1　Cancer Rate Ratios by Race (other races to white), 13 SEER Registries, 1992-2005

图 1　美国 13 个 SEER 癌症登记中心中患者癌症率比(各种族对白色人种)1992-2005

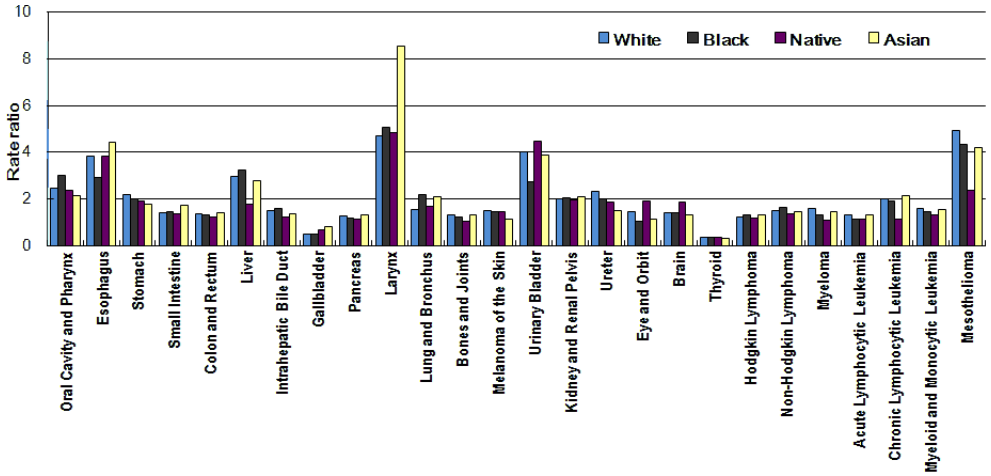

Fig. 2　Cancer Rate Ratios (male vs. female), 13 SEER Registries, 1992-2005

图 2　美国 13 个 SEER 癌症登记中心中患者癌症率比(男性对女性)1992-2005

pancreas, larynx, lung and bronchus, cervix uteri, prostate, kidney and renal pelvis, myeloma, and Kaposi sarcoma; Asians had the highest risk for stomach, liver, and thyroid cancer; natives had the highest risk for intrahepatic bile duct and gallbladder cancer.

Compared to whites (RR=1), natives and Asians had a lower risk of most types of cancers, and a higher risk of stomach, liver, intrahepatic bile duct and gallbladder cancer. The patterns by race were similar between males and females, thus we present the total representative for both the sexes.

As shown in Figure 2, through all race groups, males had a higher risk than females for most types of cancers except gallbladder cancer and thyroid cancer. Especially for Kaposi Sarcoma (not shown for the clarity of other cancers; RR=28.9 among whites, 19.6 among blacks, and 19.4 among Asians, no female cases in natives), larynx cancer, mesothelioma, urinary bladder cancer, esophagus cancer, liver cancer and oral calvity and pharynx cancer, the disparity was more prominent. The sex disparity patterns were similar among different race groups, except that RR for liver cancer, chronic lymphocytic leukemia, and mesothelioma in natives were more close to 1 compared to other race groups; RR of esophagus cancer and urinary bladder cancer in blacks were closer to 1 compared to other race groups, and RR of larynx cancer in Asians was more extreme compared to other race groups.

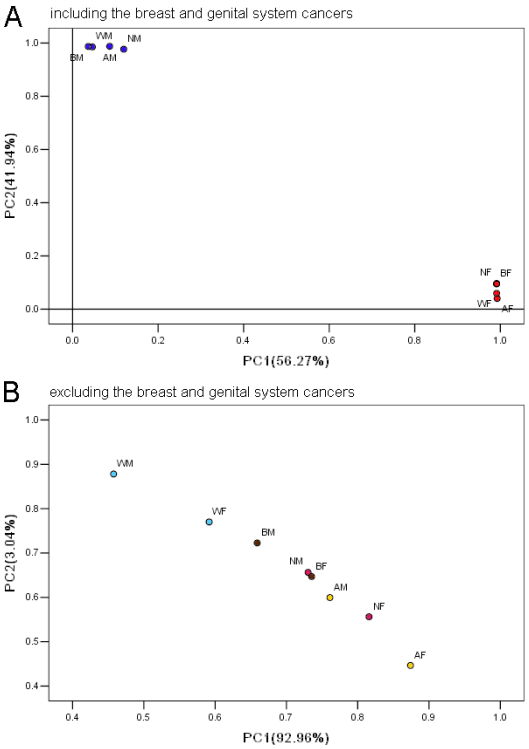

Fig. 3 Principal component (PC) analyses of race and sex groups using incidences of the 80 cancers. The components were rotated using the method of varimax with Kaiser normalization. The lables in the figure is as follows: W (White), B (Black), N (Native), A (Asian), M (Male), F (Female).

图 3 使用 80 种癌症发病率对种族和性别分组所做的主成分分析 各主成分经过了凯撒正态化的最大方差法旋转。

As shown in Figure 3, when including the cancers on breast and genital system in principle component analysis, all four female race groups clustered together, and all four male race groups clustered together; when excluding the cancers on breast and genital systems, no obvious clustering was observed. In the principle component analysis of 80 cancers, the cancers on male genital system clustered together, and the cancers on breast and female genital system clustered together, most of cancers except thyroid cancer and gallbladder cancer laid closer to male genital system cancers. Furthermore, those cancers whose incidence rates were high in whites clustered together, and those high in Asians clustered together.

APC presents the increase/decrease trend of cancer through certain period. As shown in Figure 5, during 1992-2005, no matter in which race group, incidence rates of liver cancer and thyroid cancer increased in both sexes; incidence rate of testicular cancer increased in males; and incidence rate of non-Hodgkin lymphoma increased in females. Among males, incidence rates of oral cavity and pharynx cancer, colon and rectum cancer, gallbladder cancer, larynx cancer, lung and bronchus cancer, prostate cancer and Kaposi Sarcoma (not shown for the clarity of other cancers) decreased in all race groups through 1992-2005. Among females, incidence rate of cervix uteri cancer decreased in all race groups through 1992-2005.

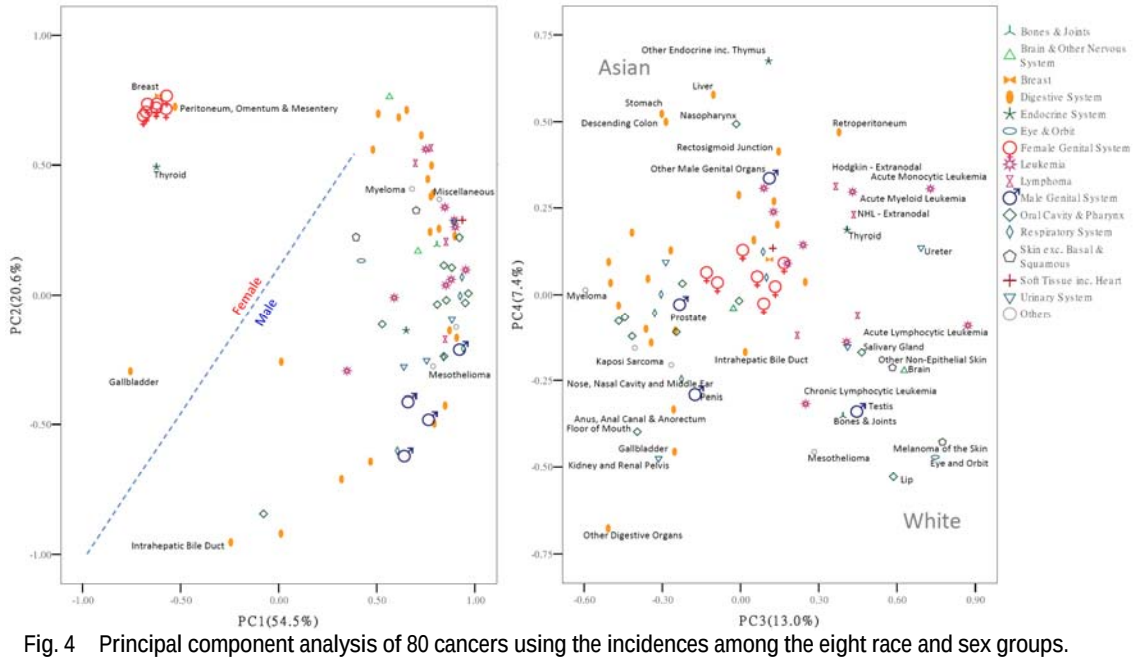

Fig. 4 Principal component analysis of 80 cancers using the incidences among the eight race and sex groups.

图 4 使用 8 个种族和性别分组发病率对 80 种癌症对所做的主成分分析

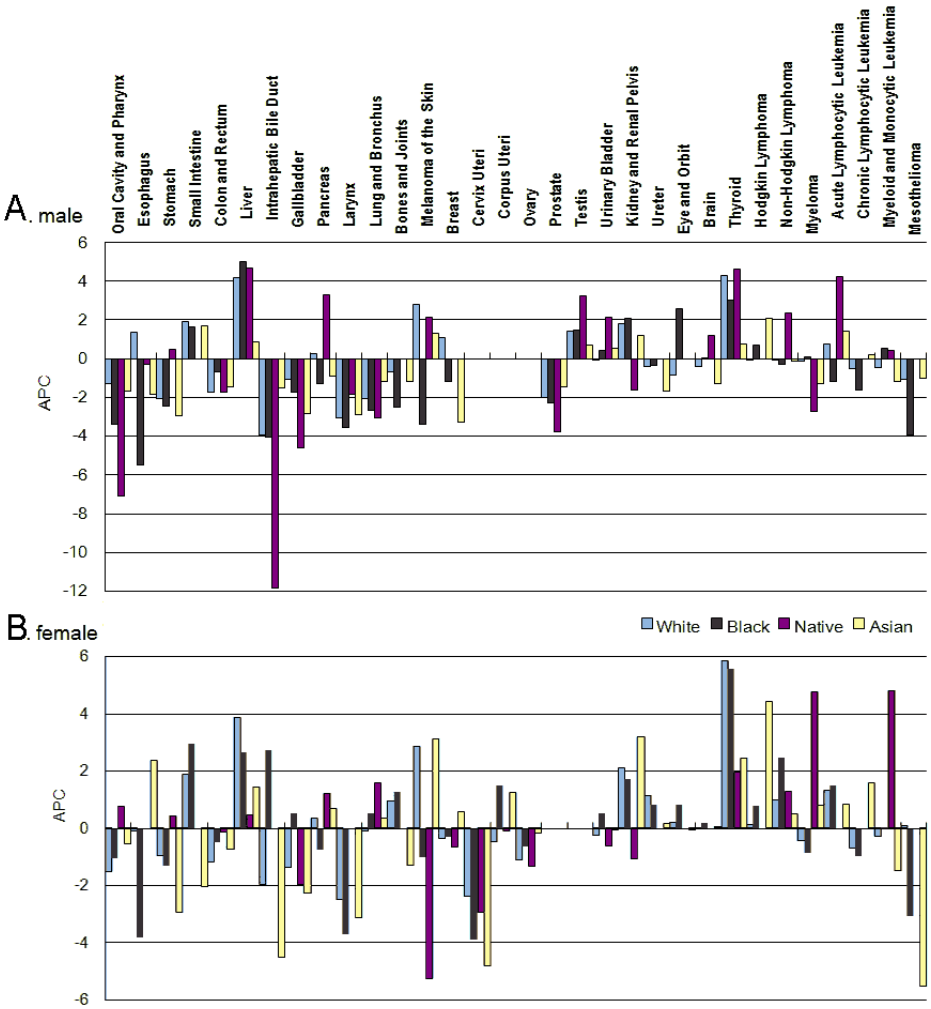

Fig. 5　Annual percent change (APC), 13 SEER registries, 1992-2005

图 5　美国 13 个 SEER 癌症登记中心癌症年变化百分比 1992–2005

Discussion

In 1992-2005 of the U.S., prostate cancer had the highest incidence rate in males and breast cancer had the highest incidence rate in females among all race groups. Lung and bronchus cancer listed second in both sexes among all race groups. Being a white or a black increased the risk of most types of cancers, with exception of stomach cancer, liver cancer and thyroid cancer of which being an Asian increases the risk, and intraphepatic bile duct cancer and gallbladder cancer of which being a native American increases the risk. Being a male increased the risk of most types of cancers among all race groups, with the exception of thyroid cancer and gallbladder cancer. The incidence rates of liver cancer and thyroid cancer kept increasing during 14 years among both sexes and all race groups.

Natural selection and cancer

An appealing question about cancer is why natural selection allows such a prevailing disease to stay in human population. A necessary condition for natural selection to occur is that the heritable variation in the population has to affect fitness, i.e. individual reproduction[9]. A hypothesis is that because most of the cancer occurs at the late age after reproduction, the fitness is not affected. Hence, natural selection does not occur to "cancer genes" that cause fatal DNA mutation or low efficiency of RNA repair. Another hypothesis states that human beings have evolved to adapt to the environments when the species *Homo sapiens sapiens* diverged and developed, which started 200 to 100 thousand years ago [10]. The environment after civilization, especially the post-industrial era, became very different. The

changing environment and the time-lag of the physical traits' adaption cause the high incidence of cancer. These two hypotheses are not contradictive to each other, but rather compensate each other.

Prostate cancer, breast cancer, and lung cancer had the highest incidences

Prostate cancer and breast cancer, the most prevalent cancer in males and females respectively, are both strongly hormonal-related and have a major impact on reproductive system. It has been suggested that the endogenous level of androgenic hormones may play a pivotal role in the cause of prostate cancer[11-13]. Besides the common risk factors for most cancer types such as an older age, family history of cancer and high-fat diet, a prolonged exposure to estrogen (such as early puberty, later menopause, later first child bearing, or parity) has been identified as the major risk factor for breast cancer [14]. Studies suggest that when comparing to the late Paleolithic ancestors and the pre-industrial ancestors, the modern men have earlier age at puberty, longer-lasting erection, more stable sexual partner, and the use of testosterone supplementation and oral contraceptive [15-17], and the modern American women have younger menarche age, later first birth age, longer time elapse between menarche and first birth, fewer pregnancy, and later menopause age, which contribute to an incredible increasing of ovulation numbers and prolonged exposure to estrogen through the whole life [18-20]. These findings support the second hypothesis: the dramatic change of sexual and reproductive behavior after prehistoric period, especially in the post industrial era, leads to the micro-environment change, and the lack of adaptation to the new environment could result in the malfunction of reproductive related organs and further cause cancer.

Prostate cancer and breast cancer share another common feature: they are both less progressive than most of other types of cancers. According to a survival analysis for SEER patients from 1988-2001, prostate patients and localized breast cancer patients, which accounted for 62% of all breast cancer patients, experienced nearly the same survival profile as the general population[21, 22]. However, the patients' quality of life is strongly affected by side-effects of the treatments, stress and anxiety from the disease, and worse sexual performance due to the disease[23-25]; thus the high incidence of these two cancers still have a huge public health impact, and effective prevention strategy of these two cancers are needed.

Lung cancer became the most common cancer in terms of both incidence and mortality in the U.S. and in the world as well in last century. With the highest rates in Europe and North America, the incidence is rapidly increasing in developing countries, notably in China and India[26]. Smoking including secondhand smoking is the most common cause of lung cancer, and the present pandemic of lung cancer followed the introduction of manufactured cigarettes with tobacco addictives, which could increase the addictiveness of cigarettes, mask symptoms and illness associated with smoking behaviors and result in a new pattern of sustained exposure of the lung to inhaled carcinogens [26, 27]. Besides smoking, other risk factors of lung cancer include exposure to substances in the workplace or in the home such as radon and asbestos, family history of lung cancer, and high-fat diet.

Incidence differences among race groups

Our results showed that being a white or a black increases the risk of most types of cancers. One explanation is that the life styles of these two race groups favor cancer development more, such as high-fat and low-vegetable diet, less physical activity and higher prevalence of obesity. Another possibility is that certain genetic composition of whites and blacks cause their susceptibility to cancers although no specific gene was identified yet. However, Caucasians in Europe and Blacks in Africa, especially Blacks in Africa, do not share the same high incidence rates for most types of cancers with

the Caucasians and blacks in the U.S.[28]. Considering as many as 94% self-reported blacks and 7% self-reported whites in the U.S. was found to be mixed-races[29], it is possible that being of mixed-races is associated with higher cancer risks. Increased risks of certain congenital malformations were observed among offspring of mixed race-ethnicity groups[30]; mixed-race adolescents showed higher risk on general health and behavior problems, and the investigators suggested that the stress associated with identity conflict or struggle with identity formation might be the culprit[31]. It was also interpreted by anthropologists that race mixing may increase the likelihood of non-optimal genetic correlation structures, which may be expected to adversely affect the organism-level physiological control[32].

As shown in Figure 1, for each type of cancer, the risks among different race groups were different. For example, the risks of melanoma of the skin and the cancer of eye and orbit were prominently higher in whites, and this could be explained by the small amount of melanin, the protective skin pigment, in whites; with the least risks for most of cancers, Asians had the highest risks for stomach cancer, which is highly associated with the high prevalence of *Helicobacter pylori* infection in Asians [33-36], and the Asian-styled diet of more smoked foods, salted fish and meat, and pickled vegetable[37]; similarly, the highest risk of liver cancer in Asians could largely be explained by the high prevalence of HBV and HCV infections, and the higher level of aflatoxin in certain Asian foods, which are the major risk factors of liver cancer[38, 39]; the highest risks of gallbladder cancer and cancer in intrahepatic bile duct were observed in native Americans, and this could be explained by the high prevalence of gallstones in the same population[40-43], which is the main established risk factor for gallbladder cancer; studies have suggested that native Americans might have a genetic predisposition to secrete high level of cholesterol in bile and develop gallbladder diseases[44, 45]. However, the reason for the difference between race groups for most types of cancers is unknown and intriguing. For example, why blacks had such a prominently high risk of myeloma, prostate cancer, larynx cancer, and esophagus cancer?—A lower social economic status and the resulted differences in access to health care and quality of medical care may explain part of the excess risks, but not all[46, 47]; despite that whites generally have a higher social economic status, they have the highest risks of testicular cancer, bladder cancer, brain cancer, lymphoma and leukemia. To what extent, these disparities could be explained by biologic and genetic factors? What kinds of roles do occupation exposure to carcinogens, diet, and cultural beliefs play? Further researches on these aspects are needed.

Incidence differences between sex groups

Except the cancers in breast and female genital systems, we found that being a male is a risk factor for most types of cancers. Although the biologic explanation for this observation is not fully known, the following factors may play important roles: (1) Endocrine factors: for example, estrogen-mediated inhibition of IL-6 production was proposed to reduces liver cancer risk in females[48-50]; (2) Genetic factors: while the X chromosome is shared by both sexes, the presence of the Y chromosome in somatic cells represents a unique peculiarity of males. The function besides sex determination of Y chromosome in males is largely unknown, but the recent studies has linked the polymorphisms on Y chromosome to male-associated diseases such as hypertension and autism, and the Y chromosome loss and rearrangements have been associated with specific types of cancer, such as bladder cancer, lung cancer and esophageal cancer [51]; (3) Life style factors: smoking, the established risk factor for many types of cancers, has a higher prevalence in males through the history[52], and may have contributed to the excess risks of lung cancer, oral and pharynx cancer, larynx cancer, esophagus cancer, stomach cancer and bladder cancer in males; alcohol drinking[52],

with its higher prevalence in males, may also contributed to the excess risk of live cancer in males. Also according to the Behavioral Risk Factor Surveillance System, females consume more fruits and vegetables than males in the U.S.[52], which is generally considered as a protective factor of cancer; (4) Occupational exposures: males have a wider range of occupations and get exposed to more occupational stressors than females, such as solvents in manufacture industries, radiation and chemicals in mineworkers, and car emissions in urban policemen and delivery drivers. (5) Psychological stress: stress weakens a person's immune system, which affects the incidence of virus-associated cancers and DNA repair ability[53], and can lead to unhealthy behaviors such as overeating, smoking or abusing drugs or alcohol, thus was proposed as a risk factor of cancer[54-56]. In almost every culture, men tend to carry more stress than women, which might play a role in the increased cancer risk in males.

Clustering analysis further confirmed the importance of sex and race in the different patterns of cancer incidences, and implying that sex is a greater risk factor than race in general.

APC and public health

The negative APC for oral cancer, colon cancer, gallbladder cancer, larynx cancer, lung cancer, prostate cancer in males, and for cervix uteri cancer in females indicates a decreased incidence of these cancers in all race groups through out the 14 years of 1992-2005, and reflects the success of public health intervention such as smoking cession and HPV vaccine and an improved health consciousness in the U.S. The positive APC for liver cancer and thyroid cancer increased in both sexes, for testicular cancer in males and for non-Hodgkin lymphoma in females indicates an increased incidence of these cancers in all race groups, and highlights the public health concerns in the U.S.

Strength of the analysis

The SEER database is a reliable data source with professional and strict quality control. Its large sample size provides our analysis a strong power for detecting the differences. Since the U.S. is an immigration country with a mixed population from various ethnicities but with a relatively similar environment background compared to the different ethnicities from their origin regions, our exploration of the genetic susceptibility differences on cancer risks among different ethnicities and sexes has a diluted bias from environmental and demographic factors. We discussed the implication of environmental and genetic factors for the observed cancer incidence differences from both epidemic-ological and evolutionary perspectives, and our interpretation added values for the annually released public SEER data.

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