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Title: U.S. national mortality differences between two Asian subgroups, nativity status, and country of origin from 2003-2011: unveiling disparities through disaggregation

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ABSTRACT

Background: With immigration and minority populations rapidly growing in the U.S, it is critical to assess how these populations fare after immigration and in subsequent generations on a national scale. Our aim is to evaluate mortality by nativity status for Chinese and Japanese Americans, and how rates compare to developed Asia counterparts (Hong Kong and Japan).

Methods: We reported all-cause and cause-specific age-standardized mortality rates using 2003-2011 U.S. death record data for Chinese and Japanese decedents aged 25 or older by nativity status and sex, and used the World Health Organization Mortality Database for Hong Kong and Japan decedents in the same years. Characteristics such as age at death, absolute number of deaths by cause, and educational attainment were also reported.

Results: We examined a total of 10,458,849 deaths. All-cause mortality was highest in Hong Kong and Japan, intermediate for foreign-born Chinese and Japanese Americans, and lowest for U.S.-born decedents. Improved mortality outcomes and higher educational attainment in foreign-born counterparts compared to developed Asia suggested selective migration. Lower rates in U.S.-born decedents were largely due to decreased cancer and communicable disease mortality rates in the U.S. Heart disease mortality was either similar or slightly higher among Chinese and Japanese Americans compared to those in developed Asia.

Conclusion: Mortality advantages in the U.S were largely due to improvements in cancer and communicable disease mortality outcomes. Furthermore, comparisons highlight the heterogeneity between commonly aggregated Asian American subgroups, and add to our understanding of the racial and environmental contributions to immigrant health disparities.

STRENGTHS AND LIMITATIONS:

- First study to examine national mortality by disaggregated Asian subgroups and nativity status, in comparison to rates in country of origin during the same years. Lack of country of origin comparisons in previous studies has limited our full understanding of how populations fare after immigration to the U.S.

- U.S. mortality death records may contain errors in the documented cause of death and racial/ethnic misclassification leading to under or over represented cause-specific death rates

- Foreign-born data does not indicate duration of residence, and does not differentiate between naturalized immigrants, permanent residents, nonimmigrants (e.g. temporary workers, students, and visitors), and illegal immigrants.

- Incomplete country comparison groups for the Chinese population (Hong Kong) as available in the WHO mortality database may limit our interpretations. However, this segmented Chinese population better controls for differences in level of economic development and access to medical technologies, etc.

INTRODUCTION

Epidemiologic transitions are well underway in developing countries, and patterns of disease are beginning to reflect those seen in developed countries. Non-communicable diseases such as cardiovascular disease (CVD) and cancers are now the leading causes of death around the world, accounting for 68% (38 million) of all deaths globally in 2012, an increase from 60% (30 million) in 2000.[1] While widely studied in native populations, our understanding of disease patterns in diverse and immigrant populations is limited. Worldwide, immigration rates are increasing at unprecedented rates, with global immigrant population projections estimated to double in size to 405 million by 2050,[2] yet little research explores how nativity status (foreign-born vs. native born) may play a role in health or mortality risk factors. Prior evidence has documented serious health disparities between immigrant populations and host populations, with many immigrants experiencing significantly worse health outcomes and disproportionately suffering from heart attacks, cancer, diabetes, strokes, and HIV/AIDS compared to native populations.[3]

Host and sending countries differ, as do the self-selection of immigrants; poor immigrants fleeing violence and poverty differ from professionals migrating for education and career opportunities. Given the lack of data quantifying immigrant health in national databases (i.e. lack of acculturation proxies, undocumented immigrants, language barriers during data collection, unrepresentative, etc.), studies find inconsistent conclusions regarding health risks in host countries. For example, some studies describe lower CVD risks and mortality among recent immigrants to developed countries compared to long-term immigrants[4-6]; others describe increased risks.[7-9] The “Healthy Migrant Effect”[10] posits that on many measures, new immigrants are healthier than average for the sending country, and may also be healthier than

subsequent generations who share similar ethnic or racial backgrounds in the host country. This selective migration reflects both that migrants are often of higher socioeconomic status (SES) than the average population of the sending country (despite lower socioeconomic positions within the host country), as well as of better health conditional on SES.[11]

However, even healthy immigrants from developing countries have been exposed to a different disease environment in childhood than those born in developed countries, and may be more prone to communicable diseases and infection-induced cancers. These conflicting factors suggest that immigrants may have worse or better health than host populations in the U.S. or other high-income countries, in addition to facing other known risk factors of immigration such as restricted health care access, language barriers, lower relative SES, discrimination, etc. Furthermore, these theories have been largely developed and tested among Hispanic/Latino populations in the U.S. (i.e. Hispanic paradox, salmon bias)[12], and much less known regarding the second largest U.S. immigrant group: Asian Americans.

Asian populations constitute over 60% of the world's population (4.4 out of 7.3 billion people).[13] Asians are the fastest growing racial/ethnic group in the U.S. and are projected to double in size to over 34 million by 2060.[14] Recent data disaggregated by individual subgroups has raised awareness about morbidity and mortality risks that impact certain Asian Americans disproportionately[15-18], but none have explored these differences by nativity status. Our study focuses on two specific Asian American subgroups, Chinese and Japanese. Census data from 2011 show that Chinese Americans are nearly five times greater than the Japanese American population (3,520,150 vs. 756,898, respectively).[19] Differences in immigration histories as described in separate study[20], have resulted in almost twice as many Chinese immigrants than Japanese immigrants in recent decades (70% vs. 39%, respectively)

with settlements in different regions throughout the U.S. Subgroups are also genetically, culturally, and behaviorally diverse, which may affect mortality risks.

Our study will shed light on potential mortality disparities between certain Asian foreign-born and U.S.-born populations, with further comparisons to developed Asia counterparts to holistically observe how these diasporas fare in the U.S. To our knowledge, this is the first study of its kind. These comparisons will add to our understanding of the racial and environmental contributions to immigrant health disparities in support of improved research agendas, clinical guidelines, and health policies.

METHODS

U.S. study population

We examined U.S. national mortality records from the National Center for Health Statistics' (NCHS) Multiple Cause of Death files from years 2003-2011. Decedents represent non-Hispanic Chinese and Japanese populations as identified on the death records by a funeral director using national guidelines. All analyses are confined to individuals aged 25 years or older to account for potential data limitations in accounting for competing risks (i.e. maternal/infant mortality) in cross-country comparisons. All 50 states and the District of Columbia were included in the analysis.

Year of death, age, location of death, nativity status (foreign-born and U.S born), race/ethnicity of the decedent and the underlying cause of death (disease or injury that initiated the events resulting in death) were identified from death certificates. Note that the foreign-born variable only indicates, "born outside of the United States", and does not provide country of birth details. "Underlying cause of death" was coded by NCHS using the International Classification of Diseases, 10th revision (ICD-10). Year by year population estimates were calculated from the

2000 and 2010 U.S. Census data using linear interpolation for 2003-2009 and extrapolation for 2011. To evaluate the appropriateness of the linear interpolation approach, we used American Community Survey (ACS) data to plot total US population by year in each group of interest and none of these plots appeared to show a consistent departure from linearity. Additionally, to calculate population estimates by nativity status, we used the Public Use Microdata Sample (PUMS) from the 5-year 2005-2009 ACS database to determine proportions of foreign-born populations for each Asian subgroup, age-group, and sex by state and aggregated those numbers to the nation. For ACS, use of 5-year data is required to provide complete coverage, and the 2005-2009 data are the earliest available and also cover the middle 5 years out of 9 included. However, analyses of individual years will be affected by changes in the percentages of foreign-born and U.S.-born. We adjusted the estimates of percent foreign-born using a linear adjustment based on the overall change in foreign-born from the 2000 and 2010 U.S. censuses.

Chinese and Japanese counterparts in developed Asia

To compare Asian-American mortality to that of ethnic counterparts living in developed Asia, we examined decedent-level mortality records from Hong Kong and Japan from the World Health Organization (WHO) Mortality Database from 2003-2011 which can be obtained from their website (http://www.who.int/healthinfo/mortality_data/en/). Although Chinese Americans may come from a range of regions (PRC, Hong Kong, Macao, Taiwan, southeast Asia), we selected Hong Kong as representative of ethnic Chinese living in developed Asia because of Hong Kong's high quality cause-specific mortality data and similarities in potential conditions shaping health outcomes (affluence, urbanization, healthcare, etc.). Since Hong Kong has among the best survival rates of all China's cities/provinces[21], this comparison helps to isolate the

differences associated with lifetime exposure to an earlier phase of the epidemiologic transition among Chinese living in Asia, rather than current living standards. Whole country data for Japan was available and used for comparison to Japanese American decedents. Average annual population estimates by age and sex from the WHO database were used to calculate age-standardized mortality rates.

Statistical Analysis

The following causes of death (ICD-10 codes) were chosen as outcome variables: All Cause, All Cancer (C00-C97), Heart Disease (I00-I09, I13, I20-I51), Cerebrovascular Disease (I60-I69), Communicable diseases, maternal, and nutritional conditions (A00-B99, G00-G04, N70-N73, J00-J06, J10-J18, J20-J22, H65-H66, O00-O99, P00-P96, E00-E02, E50, D50-D53, D64.9, E51-E64), Influenza and pneumonia (J09-J18), Alzheimer's Disease (G30), Accidents (V01-X59, Y85-Y86), and Chronic Lower Respiratory Diseases (J40-J47). The classification scheme used to categorize all 358 causes of deaths was selected to encompass the leadings causes of death in both the U.S. and developed Asia, including the primary non-communicable diseases as well as an aggregated communicable disease category.[22] For both WHO and U.S. data, we calculated raw mortality rates for these categories by summing death counts for each category in the year (for year-by year analyses) or nine years (for composite analyses) and dividing by the corresponding population to produce age, race, sex, cause-specific raw mortality rates. We directly standardized these rates with the 2000 WHO Standard Population to calculate age-standardized mortality rates for each group of interest.[23]

RESULTS

We examined a total of 10,458,849 (352,822 in Hong Kong, 9,959,489 in Japan, and 146,538 in the U.S.) deaths from 2003 to 2011. Table 1 presents the demographics of the Chinese and Japanese decedents during the study period. In general, females constituted about half of each sub-group, with the exception of foreign-born Japanese (78% females). The median age of death was also similar across Chinese subgroups, around 80 years old, whereas Japanese had a seven-year difference in median age of death between U.S.-born and foreign-born decedents (84 years old vs. 77 years old, respectively). The higher educational attainment of decedents in the U.S., compared to Hong Kong and Japan populations may support selective migration. Among both Chinese and Japanese, foreign-born decedents have received more education than the adult populations in developed Asia, as measured by rates of high school completion, and U.S.-born decedents attained either similar (among Japanese) or higher rates of high school completion (Table 1). Among Chinese Americans, "less than secondary (high school) completed" was 21% for U.S.-born vs. 41% for foreign-born, and "secondary completed" was 52% for U.S born vs. 35% for foreign-born. Educational attainment was similar for Japanese-Americans, regardless of nativity; but over 60% of Japanese-American decedents had completed high school, compared to only 38% of the Japan population.

Table 1. Study characteristics using death record data for Chinese and Japanese populations in the U.S. and living in Asia, 2003-2011.

	Chinese			Japanese		
	Hong Kong	Foreign born	US Born	Japan	Foreign-born	US Born
Characteristics						
Female (%)	44	48	46	46	78	47
Age at death						
25-44	14,344	2,843	579	244,460	445	600
45-64	58,852	12,211	1,716	1,341,391	2,118	4,174
65-74	65,330	12,324	1,197	1,772,960	3,437	4,373
75-84	115,505	23,306	3,064	3,118,854	6,114	13,941
85+	98,791	27,274	3,740	3,481,824	2,517	20,565
Median age at death	78	80	81	80	77	84

Total number of deaths	352,822	77,958	10,296	9,959,489	14,631	43,653
Avg. population size	5,087,389	1,805,385	316,337	95,717,355	260,884	371,188
Absolute numbers of deaths due to						
Cancer	111,090	24,841	2,657	3,012,577	4,913	9,837
Heart Disease	54,964	18,019	2,806	1,631,231	2,791	11,284
Cerebrovascular Diseases	30,958	6,569	805	1,144,770	1,103	3,726
Communicable, maternal, and nutritional conditions	54,162	5,373	571	1,245,295	813	2,565
Influenza and Pneumonia	43,910	3,427	343	990,576	357	1,697
Alzheimer's Disease	102	1,473	242	25,988	430	1,545
Accidents	6,612	2,517	392	363,844	567	1,277
Chronic Lower Respiratory Diseases	18,541	2,866	238	172,038	468	1,226
*Education Attainment						
Less than secondary completed	52.4	41.0	21.0	42.9	17.0	21.0
Secondary (high school) Completed	29.0	35.0	52.0	37.9	66.0	63.0
Tertiary (college) Completed	18.6	24.0	27.0	19.2	17.0	16.0

*International education attainment (i.e. Hong Kong and Japan) was obtained from Barro-lee Educational Attainment dataset, based on the population in 2005 (approximate mid-year) for individuals aged 25+; data can be retrieved at: http://barrolee.com/; individual-level educational data not available within W.H.O mortality records.

Consistent with 2010 Census population data[24], a much larger proportion of Chinese American decedents was foreign-born, whereas for Japanese American decedents a larger proportion was U.S.-born. According to the absolute number of deaths due to a specific cause (Table 1), cancer ranked as the top cause of death for foreign-born and developed Asia decedents in each of the subgroups (when females and males are aggregated), but heart disease ranked as the leading cause for all U.S.-born counterparts. Cerebrovascular disease ranked third for both the U.S.-born and foreign-born Asian American subgroups, but ranked 4th (with communicable diseases ranking as 3rd) for countries of origin.

All-cause mortality rates were highest in Hong Kong (434 per 100,000 for females, 783 for males) and Japan (408 for females, 799 for males), intermediate for foreign-born Chinese- (319 for females, 468 for males) and Japanese-Americans (429 for females, 614 for males), and lowest for U.S.-born Chinese (260 for females, 383 for males) and Japanese (345 for females,

600 for males) (Table 2). Overall death rates are lower in US born decedents compared to countries of origin, and this is largely due to the difference in cancer deaths in the US for both Chinese and Japanese compared to countries of origin. Heart disease rates were either similar or slightly higher among Chinese and Japanese living in the U.S. compared to those living in Asia, with a higher mortality burden from heart disease for U.S born decedents. Mortality rates for communicable diseases were much higher in Asia. The Central Illustration (Figure 1) pictorially demonstrates mortality differences among subgroup populations (ethnicity, nativity status, sex) by top causes of death.

Table 2. Age-adjusted mortality rates with 95% confidence intervals by top causes of death for Chinese and Japanese populations in the US and living in Asia (2003-2011). Data based on individuals aged 25+ years.

			Asia	U.S.	
			Hong Kong	Foreign-born	U.S.-born
FEMALE		**Cause of Death**	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**
	Chinese	All cause	434.4 (432.1-436.7)	319.0 (315.7-322.3)	260.3 (252.2-268.6)
		Cancer	143.9 (142.5-145.3)	107.2 (105.2-109.2)	84.1 (79.1-89.3)
		Heart Disease	68.5 (67.6-69.4)	69.4 (67.9-70.9)	57.2 (53.6-60.9)
		Cerebrovascular Diseases	41.1 (40.4-41.8)	29.9 (28.9-30.9)	21.1 (18.9-23.5)
		Communicable, maternal, and nutritional conditions	58.2 (57.4-58.9)	19.8 (19.0-20.6)	13.3 (11.6-15.2)
		Influenza and Pneumonia	46.1 (45.5-46.8)	12.1 (11.5-12.7)	7.7 (6.5-9.2)
		Alzheimer's Disease	0.1 (0.1-0.2)	6.9 (6.5-7.4)	6.1 (5.2-7.4)
		Accidents	6.5 (6.2-6.8)	10.2 (9.6-10.9)	9.1 (7.6-10.8)
		Chronic Lower Respiratory Diseases	12.8 (12.5-13.2)	7.2 (6.7-7.7)	5.1 (4.0-6.4)
			Japan		
	Japanese	All cause	408.4 (408.0-408.9)	429.0 (420.6-437.7)	344.9 (338.4-351.6)
		Cancer	134.7 (134.4-135.0)	150.8 (145.7-156.2)	103.9 (100.0-108.0)
		Heart Disease	64.5 (64.3-64.7)	75.9 (72.5-79-5)	69.5 (67.0-72.3)
		Cerebrovascular Diseases	46.7 (46.5-46.8)	33.3 (30.9-35.8)	30.2 (28.4-32.2)
		Communicable, maternal, and nutritional conditions	41.7 (41.6-41.9)	23.4 (21.5-25.5)	18.5 (17.1-20.2)
		Influenza and Pneumonia	30.4 (30.3-30.5)	9.7 (8.5-11.1)	9.9 (8.9-11.0)
		Alzheimer's Disease	1.1 (1.1-.1.1)	13.8 (12.4-15.4)	9.7 (9.0-10.6)
		Accidents	15.4 (15.3-15.5)	15.8 (14.1-17.8)	10.6 (9.2-12.2)
		Chronic Lower Respiratory Diseases	4.0 (4.0-4.0)	13.1 (11.8-24.6)	6.8 (6.0-7.9)
			Asia	**U.S.**	
MALE			**Hong Kong**	**Foreign-born**	**U.S.-born**
		Cause of Death	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**
	Chinese	All cause	783.0 (779.5-786.5)	468.1 (463.5-472.6)	383.2 (372.6-394.0)
		Cancer	269.7 (267.6-271.7)	160.6 (157.9-163.3)	102.1 (96.6-108.0)
		Heart Disease	111.0 (109.7-112.3)	103.9 (101.7-106.0)	112.8 (107.1-118.8)
		Cerebrovascular Diseases	60.2 (59.2-61.1)	34.1 (32.9-35.4)	26.0 (23.4-29.0)
		Communicable and nutritional conditions	113.4 (112.1-114.6)	32.5 (32.0-33.7)	20.5 (18.2-23.1)
		Influenza and Pneumonia	90.8 (89.7-92.0)	20.0 (19.1-21.0)	11.1 (9.4-13.0)

	Alzheimer's Disease	0.2 (0.1-0.2)	5.3 (4.9-5.8)	5.2 (4.2-6.5)
	Accidents	20.2 (19.6-20.8)	17.7 (16.8-18.7)	16.0 (13.9-18.4)
	Chronic Lower Respiratory Diseases	51.0 (50.1-51.9)	21.4 (20.5-22.4)	9.4 (7.8-11.2)
		Japan		
Japanese	All Cause	799.1 (798.3-799.8)	613.8 (591.5-636.8)	600.2 (591.1-609.5)
	Cancer	268.2 (267.8-268.6)	185.6 (173.6-198.3)	159.1 (154.4-164.0)
	Heart Disease	115.0 (114.8-115.3)	142.9 (132.1-154.4)	157.8 (153.3-162.5)
	Cerebrovascular Diseases	80.2 (80.0-80.4)	43.1 (37.3-49.7)	39.4 (37.3-41.8)
	Communicable and nutritional conditions	90.1 (89.8-90.3)	32.9 (27.7-38.8)	30.6 (28.7-32.7)
	Influenza and Pneumonia	71.1 (70.9-71.3)	21.2 (17.0-26.3)	18.8 (17.4-20.3)
	Alzheimer's Disease	1.3 (1.2-1.3)	9.7 (6.9-13.4)	9.7 (8.8-10.7)
	Accidents	36.4 (36.2-36.6)	33.2 (28.5-38.6)	26.5 (24.2-29.1)
	Chronic Lower Respiratory Diseases	16.0 (15.9-16.1)	15.4 (11.8-19.8)	18.3 (16.9-20.0)

Year by year all-cause mortality rates were plotted (Figure 2). Notably, Chinese trends indicate that mortality rates steadily decreased in Hong Kong since 2003 (APC for F: -10.5, $p<0.05$; M: -6.0, $p<0.05$). Japanese all-cause rates have decreased in Japan over the study period as well (F: -4.2, $p<0.05$; M: -10.7, $p<0.05$)(Table S2). Mortality rates by year with 95% CIs and annual percent change (APC) estimates with p-values (Table S1, S2) and cause-specific mortality rates (Figure S1, S2) were presented as supplemental data. Cancer, heart disease, and cerebrovascular diseases decreased in Hong Kong for females and males (Figure S1). The same is true for Japan, in addition to communicable diseases (Figure S2). Conversely, cancer mortality increased by 2% for Chinese and 4% for Japanese foreign-born females, and 9% for Japanese foreign-born males (Table S1, S2).

DISCUSSION

Mortality statistics in the U.S. continue to combine foreign-born and U.S born individuals together, masking potential immigrant health disparities. Our study shows that U.S.-born Asians have better mortality outcomes than foreign-born Asians, an opposite effect to what has been observed among Hispanic/Latinos in the U.S. Furthermore, our study shows better mortality outcomes and higher educational attainment for foreign-born counterparts compared to

populations in native countries, suggestive of selective migration. We explored cause-specific mortality to provide insight into where most of these mortality gains were made, largely from improvements in cancer mortality in the U.S.-born group when compared to decedents in countries of origin.

Previous studies of aggregated foreign-born Asian Americans have shown lower rates of all-cause mortality compared to their U.S.-born counterparts[25], consistent with patterns shown in Hispanic/Latino immigrants. As we disentangle the ambiguities in mortality outcomes by Asian subgroup, we show that these patterns are not equally reflected among groups. A similar study disaggregating Asian Americans by foreign- and U.S.-born decedents showed that while Asian Indian, Korean, and Vietnamese foreign-born populations had lower all-cause mortality rates and a higher life expectancy than their U.S.-born counterparts, the opposite was true for Chinese, Filipino, and Japanese immigrants.[26] More research must be done to investigate the forces that lead to large variations between immigrant groups in the U.S., and how the health of immigrant children may differentiate from their own (i.e. generational differences). One study speculated that health advantages over other ethnicities might accrue with longer histories of settlement in the U.S. like with Japanese and Chinese- Americans.[27] Such analyses may provide important clues as to what degree socio-environmental contexts may play over genetic risk factors in immigrant health.

Gleaning from what we do know, population-level/infrastructural differences that either support or undermine health may contribute to observed mortality patterns. For example, the mortality advantage among Asians in the U.S. (foreign-born and U.S.-born) compared to developed Asia counterparts is likely explained by differences in medical technologies and screening practices, decreased exposure to communicable diseases, and lower smoking rates.

Selective migration may also help explain the observed attenuation in foreign-born mortality rates and increased education attainment levels compared to developed Asia counterparts. A "healthy" migrant does not exclusively indicate an advantage over U.S.-born populations, but rather how they fare in comparison to sending countries as well. Mexican migrants to the U.S. have shown not to be a selected group of their home population, unlike migrants from other distant countries such as in Asia[28] – which may in part explain contrasting patterns to Hispanic/Latino immigrant mortality.

The mortality advantage for U.S.-born decedents compared to foreign-born counterparts may be largely attributed to inadequate access to health care and health insurance for immigrant populations according to the Migration Policy Institute.[29] Their analyses using Census data show that immigrants were more than three times as likely to be uninsured (44%) as native-born citizens (13%). According to 2008-2010 ACS data one study reported health insurance coverage among the Asian subgroups, indicating that the subgroups highlighted in this study were on the lower end of the uninsured population, Japanese (7%) and Chinese (14%), compared to the national average (16%).[30]. This same study showed that Asians with larger percentages of native-born populations were less likely to be uninsured. Additionally, increased mortality rates for foreign-born may also indicate the old age sequelae of the Barker hypothesis: maladaptation to sedentary calorie-rich diets among those exposed to scarcity in utero and in youth.[31]

Our study has also shown that different causes of death were more important for each subgroup. Increased cancer mortality rates in foreign-born groups compared to U.S.-born are likely caused by higher exposure levels to communicable/infectious diseases in countries of origin and again, lack of access to preventive screenings for early detection. Liver cancer has shown to be more important for Chinese immigrants, which likely reflects the high rates of

chronic Hepatitis B virus in certain Asian countries, such as China and Vietnam.[32] Other studies have demonstrated that stomach cancer mortality rates are higher for foreign-born Japanese, reflecting the influence of rates of Helicobacter pylori infection and traditional dietary intake of pickled and salted foods.[26, 33]

Increased heart disease mortality rates among Japanese men, and an overall greater proportion of heart disease deaths among all U.S.-born subgroups, may be attributed to acculturation and higher CVD risk factors as illustrated by the Ni-Hon-San study.[34, 35] The Honolulu Heart Program (HPP) then evaluated CVD among Japanese men living in Honolulu within the Ni-Hon-San cohort and showed that risk factor levels of these men had risen to levels comparable to non-Hispanic whites (NHWs).[36] However, stroke and coronary heart disease had remained lower than for non-Hispanic whites. The children of HHP study participants were also followed, and investigators found that BMI and diabetes prevalence were substantially higher in children compared to their fathers, but total cholesterol was lower in children.[37] These observations suggest that acculturation such as adopted dietary and lifestyle behaviors similar to majority populations in the U.S. contribute to changes in CVD risk factors (i.e. increased BP and decreased smoking and alcohol intake) and, subsequently, increased heart disease and decreased stroke mortality, respectively, as also shown in our findings.

Traditionally, mortality analyses are a valid indicator of a population's health status, yet our findings warrant further investigation upon the socioeconomic indicators impacting mortality outcomes, other health risk factors, and health care utilization differences between immigrant populations and U.S.-born counterparts to fully understand how mortality discrepancies evolved. In effort to improve current targeted prevention strategies for racial/ethnic minorities, our data suggest that heart disease risk factor modification is more important for U.S.-born Chinese and

Japanese (similar to majority population) than foreign-born counterparts. Cancer screenings may be more important for foreign-born Chinese and Japanese, such as screening for gastric cancer and liver cancer (infection-induced cancers).

Limitations include the use of the U.S. mortality death records, which may contain errors in the documented cause of death and racial/ethnic misclassification leading to under or over represented cause-specific death rates.[38] We acknowledge that the sample for Japanese foreign-born men (approx. 3,200 decedents, or 22% of Japanese foreign-born) is small, which may limit our interpretation for direct comparisons with other subgroups. The gender imbalance in Japanese migration to the U.S. has been previously explained by the influx of "war brides" from 1952-1960, as Japanese women entered the U.S. as wives and fiancées of American military personnel.[39] Additionally, foreign-born data does not indicate duration of residence, and does not differentiate between naturalized immigrants, permanent residents, nonimmigrants (e.g. temporary workers, students, and visitors), and illegal immigrants, which may influence mortality rates.[10] Incomplete country comparison groups for the Chinese population (Hong Kong) as available in the WHO mortality database may limit our interpretations. However, this segmented Chinese population better controls for differences in level of economic development and access to medical technologies, etc. Population sizes are estimated rather than known, so the precision of age-standardized mortality rates may be less than expected and the confidence intervals too narrow.

From a theoretical standpoint, it is important to consider that all-cause mortality rates among foreign-born groups may be underestimated by reverse migration causing "statistical immortality". This arises if immigrants leave the U.S. in old age and die in other countries without dropping appropriately from the U.S. Census denominator. Reverse migration may be

highly selective, with sicker immigrants more inclined to return to their country of origin if and when they cannot work, and for those with chronic (rather than sudden) causes of death. A recent study found selective reverse migration to be true among Mexican migrants in the U.S., with higher probabilities of Mexican migrants in poor health to return home (and lower probabilities of return in improving health).[40] Statistical immortality may differ by Asian subgroup, given differences in ease of return migration (e.g. easier to return to Japan than China) and social protection systems for the elderly (e.g. China vs. Japan).

A substantial knowledge gap exists on this topic largely because comparing mortality rates across countries is complex, in light of differences in disease definitions, racial/ethnic classifications, numbers of years for which data is available, and methods of standardization. Accounting for these limitations, our analyses provide an empirical basis for understanding health disparities among diverse Asian immigrants in the U.S, compared to counterparts in developed Asia. The main findings of our study highlight the importance that not only race/ethnicity plays, but also nativity status, in unveiling mortality disparities for minority populations in the U.S.

FIGURE LEGENDS

Figure 1. Central Illustration: Age-adjusted mortality rates for Chinese and Japanese populations by top causes of death (cancer, heart disease, cerebrovascular disease, and communicable diseases); combined study years (2003-2011).

Figure 2. Year by year all cause age-adjusted mortality rates plotted from 2003-2011 for Chinese and Japanese populations by sex.

Figure S1. Year by year cause-specific age-adjusted mortality rates (cancer, heart disease, cerebrovascular disease, and communicable disease) plotted from 2003-2011 for Chinese populations by sex.

Figure S2. Year by year cause-specific age-adjusted mortality rates (cancer, heart disease, cerebrovascular disease, and communicable disease) plotted from 2003-2011 for Japanese populations by sex.

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CONTRIBUTORSHIP STATEMENT

KGH and KE designed the analytic plan and formulated research questions/hypotheses. KK and DB data cleaned, analyzed the data, and generated figures. KE, MB, MC, LP provided content expertise and critical overview of the various drafts. MC and LP are study co-principal investigators. All authors were involved in interpreting findings and revising the first draft, which was written by KGH. All authors approved the final draft of the manuscript.

COMPETING INTERESTS

No financial disclosures or competing interests to disclose.

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DATA SHARING

No additional data available.

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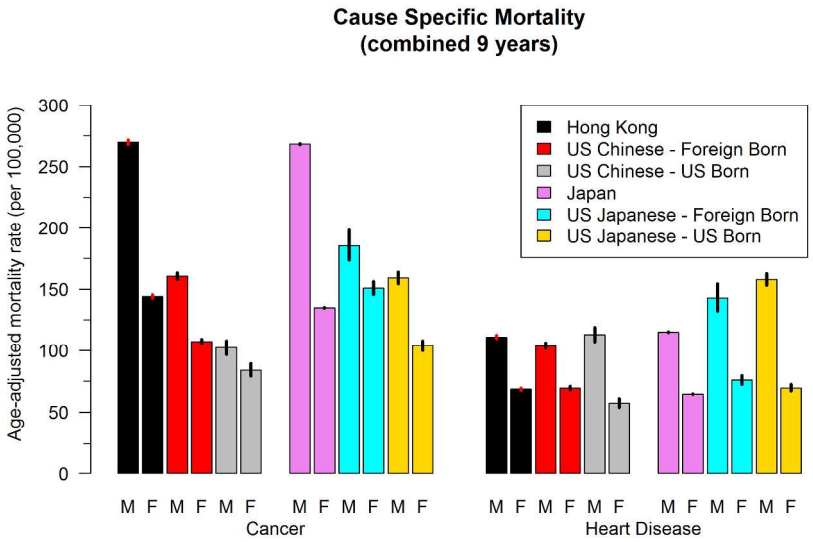

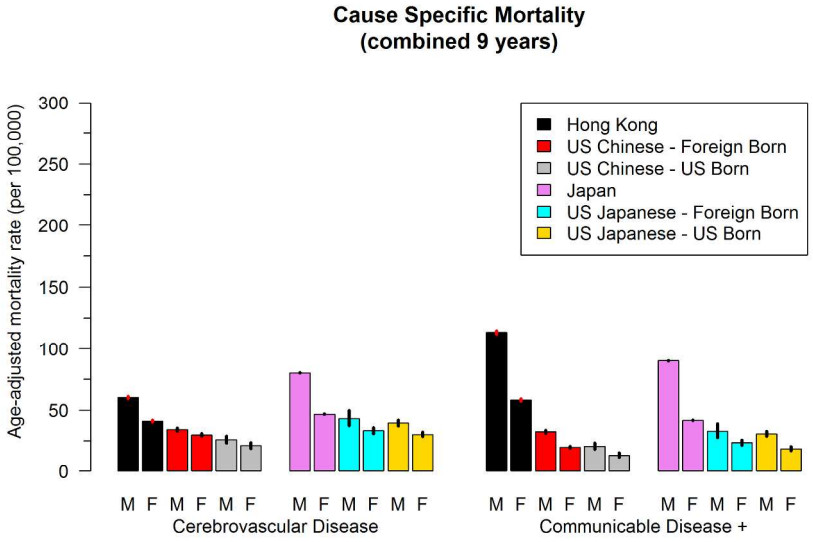

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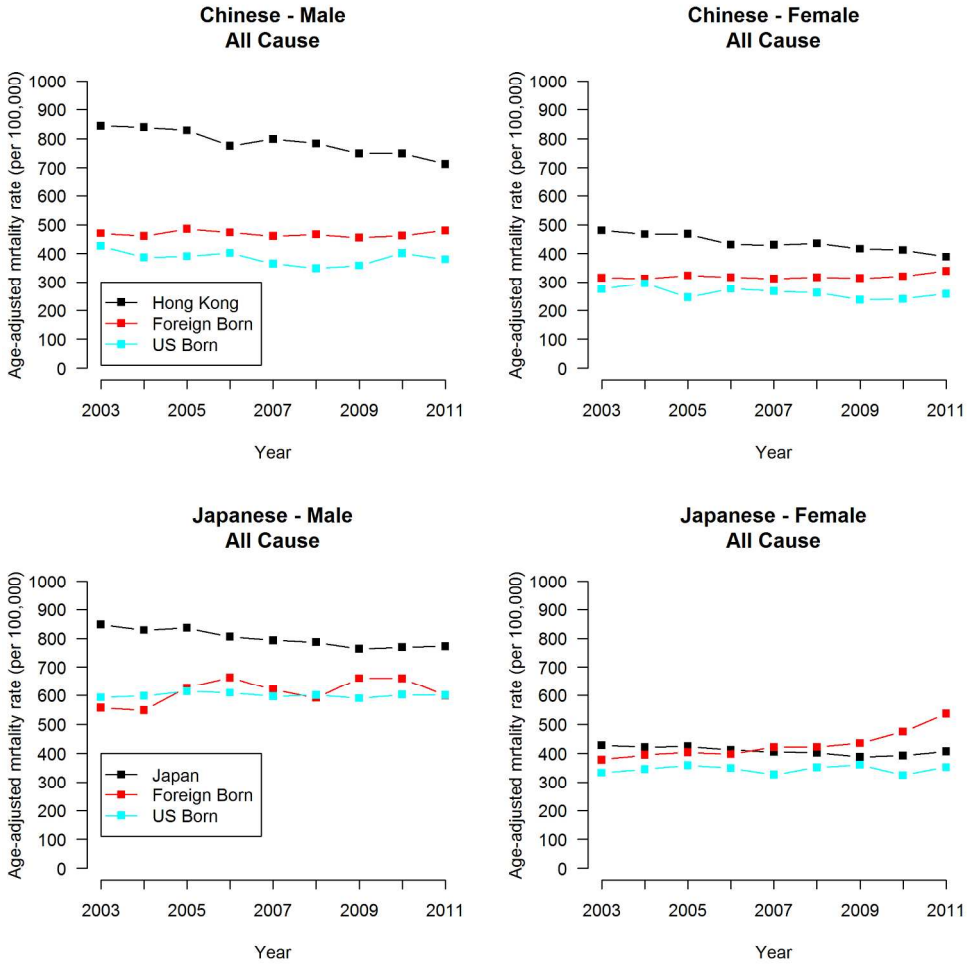

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SUPPLEMENTARY DATA

Table S1. Year by year mortality age-standardized mortality rates, regression slopes (annual rate of change) and p-values for all cause mortality, cancer, heart disease, cerebrovascular disease, and communicable diseases by sex and Chinese population (Hong Kong, Foreign-Born, and US-born) for the years 2003-2011.

		HONG KONG			FOREIGN BORN			US BORN		
ALL CAUSE		**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**
FEMALE	**2003**	480.32	472.51	488.25	314.94	304.41	325.82	274.85	247.83	304.64
	2004	467.25	459.69	474.92	312.07	301.79	322.69	294.80	267.43	324.82
	2005	467.69	460.27	475.23	323.30	312.98	333.95	245.26	221.53	271.48
	2006	430.90	423.88	438.03	316.58	306.53	326.95	275.06	250.00	302.54
	2007	429.98	423.15	436.92	312.00	302.18	322.12	266.77	242.62	293.24
	2008	435.41	428.67	442.25	316.75	307.05	326.76	261.63	238.42	287.05
	2009	416.55	409.99	423.20	313.34	303.85	323.13	236.55	214.94	260.29
	2010	412.19	405.79	418.69	320.43	310.92	330.23	239.80	218.41	263.25
	2011	388.96	382.86	395.16	338.68	329.03	348.61	257.35	235.18	281.55
	Slope (p-value)	**-10.47 (p<0.05)***			1.67 (0.13)			-4.43 (0.06)		
MALE	**2003**	843.97	832.22	855.86	470.07	455.49	485.09	426.50	390.13	465.93
	2004	838.96	827.45	850.62	460.49	446.32	475.07	386.44	352.71	423.09
	2005	828.35	817.14	839.70	485.26	470.93	500.00	390.37	357.97	425.51
	2006	774.99	764.36	785.76	473.29	459.35	487.63	402.06	369.47	437.31
	2007	798.80	788.25	809.48	460.43	446.92	474.31	364.61	334.21	397.58
	2008	783.53	773.26	793.94	466.40	453.02	480.15	348.49	319.55	379.87
	2009	749.35	739.46	759.36	455.13	442.10	468.53	358.16	328.77	389.97
	2010	749.44	739.73	759.27	462.28	449.30	475.62	401.12	370.84	433.69
	2011	713.06	703.75	722.49	479.69	466.67	493.05	380.00	351.40	410.80
	Slope (p-value)	**-15.69 (p<0.05)***			-0.39 (0.78)			-4.33 (0.19)		
CANCER										
FEMALE	**2003**	149.78	145.17	154.53	101.78	95.59	108.34	97.40	80.27	117.62
	2004	151.75	147.20	156.43	102.58	96.48	109.05	79.07	64.39	96.66

	2005	152.56	148.06	157.20	108.11	101.93	114.63	74.83	61.21	91.18
	2006	144.30	139.99	148.74	101.91	96.00	108.15	103.68	87.33	122.70
	2007	139.47	135.30	143.75	103.95	98.07	110.15	87.72	72.92	105.12
	2008	140.40	136.29	144.63	107.75	101.87	113.96	79.41	66.08	95.16
	2009	142.97	138.86	147.19	102.95	97.30	108.92	77.91	64.68	93.55
	2010	139.42	135.43	143.51	111.78	105.94	117.92	70.11	57.73	84.82
	2011	137.04	133.13	141.04	120.94	114.92	127.25	89.04	75.14	105.19
	Slope (p-value)	**-1.85 (p<0.05)***			**1.66 (0.03)***			-1.31 (0.39)		
MALE										
	2003	294.78	287.90	301.80	155.86	147.42	164.73	115.77	96.80	137.97
	2004	286.97	280.29	293.80	157.22	148.88	165.97	109.84	91.58	131.22
	2005	289.27	282.67	296.00	166.45	158.00	175.31	95.43	79.15	114.64
	2006	275.14	268.82	281.60	159.65	151.51	168.20	110.41	92.92	130.76
	2007	272.20	266.04	278.50	165.31	157.16	173.84	99.39	83.28	118.25
	2008	261.51	255.54	267.60	157.35	149.51	165.56	90.10	75.58	107.18
	2009	257.82	252.00	263.77	156.29	148.59	164.34	92.85	77.89	110.35
	2010	253.57	247.90	259.37	161.03	153.32	169.09	107.18	91.33	125.46
	2011	248.34	242.79	254.01	165.24	157.52	173.31	101.46	86.41	118.85
	Slope (p-value)	**-6.04 (p<0.05)***			0.44 (0.46)			-1.51 (0.20)		
HEART DISEASE										
FEMALE	**2003**	73.81	70.90	76.85	76.08	71.14	81.37	56.51	45.80	69.92
	2004	76.94	74.01	79.98	69.61	64.99	74.56	71.68	59.31	86.67
	2005	73.88	71.07	76.80	76.00	71.24	81.09	61.58	50.16	75.58
	2006	68.11	65.46	70.86	74.36	69.73	79.30	51.01	41.44	62.96
	2007	71.75	69.10	74.51	66.35	62.04	70.96	62.46	51.56	75.72
	2008	72.31	69.72	75.00	67.90	63.63	72.46	56.18	46.21	68.39
	2009	64.88	62.43	67.43	69.80	65.55	74.34	55.43	45.64	67.39
	2010	62.93	60.56	65.38	63.66	59.65	67.95	53.11	44.10	64.16
	2011	56.30	54.12	58.58	63.14	59.19	67.35	49.55	40.44	60.73
	Slope (p-value)	**-2.10 (p<0.05)***			**-1.49 (0.04)***			-1.51 (0.08)		

MALE	**2003**	112.71	108.45	117.12	112.42	105.45	119.83	130.00	110.47	152.63
	2004	120.86	116.53	125.33	109.31	102.54	116.49	115.94	97.74	137.16
	2005	114.80	110.67	119.08	108.46	101.81	115.51	119.02	101.36	139.50
	2006	104.81	100.93	108.82	112.28	105.62	119.33	120.30	103.12	140.15
	2007	114.75	110.80	118.83	102.24	96.00	108.85	104.66	88.67	123.29
	2008	116.37	112.47	120.40	106.71	100.42	113.37	117.57	100.75	136.93
	2009	109.40	105.67	113.25	99.64	93.65	106.00	102.40	87.09	120.18
	2010	109.56	105.89	113.36	95.48	89.72	101.60	109.13	93.59	127.04
	2011	100.75	97.30	104.32	92.10	86.53	98.01	102.11	87.67	118.81
	Slope (p-value)	-1.35 (0.09)			**-2.43 (p<0.05)***			**-2.80 (0.01)***		
CEREBROVASCULAR										
FEMALE	**2003**	51.03	48.59	53.59	34.34	30.99	38.05	27.40	19.59	38.16
	2004	46.37	44.09	48.78	34.08	30.80	37.71	29.58	21.58	40.41
	2005	46.41	44.17	48.77	29.22	26.23	32.55	18.81	13.06	27.23
	2006	42.45	40.34	44.67	31.38	28.29	34.80	16.62	10.91	25.06
	2007	41.09	39.06	43.22	27.70	24.90	30.82	26.26	19.79	35.09
	2008	41.92	39.90	44.04	28.31	25.48	31.46	23.60	17.13	32.47
	2009	36.42	34.56	38.37	27.23	24.48	30.28	16.02	11.14	23.21
	2010	36.07	34.25	37.99	28.12	25.41	31.12	19.18	13.83	26.72
	2011	32.65	30.95	34.44	29.69	26.91	32.76	14.99	10.40	21.74
	Slope (p-value)	**-2.08 (p<0.5)***			**-0.73 (0.02)***			-1.32 (0.05)		
MALE	**2003**	70.50	67.14	74.01	40.14	35.99	44.73	27.13	18.38	39.29
	2004	69.49	66.22	72.90	38.26	34.31	42.64	28.09	20.20	38.96
	2005	63.99	60.93	67.20	37.60	33.73	41.88	33.73	24.70	45.73
	2006	58.76	55.90	61.76	34.85	31.16	38.94	34.83	26.02	46.44
	2007	62.45	59.55	65.48	32.90	29.39	36.80	23.08	16.17	32.74
	2008	62.10	59.27	65.05	32.01	28.60	35.80	17.97	11.74	27.00
	2009	57.03	54.36	59.81	32.00	28.63	35.73	25.93	18.15	36.44
	2010	52.34	49.84	54.97	29.25	26.08	32.78	23.99	17.17	33.29
	2011	50.77	48.35	53.31	32.01	28.73	35.64	21.75	15.63	30.21

Slope (p-value)		**-2.35 (p<0.05)***			**-1.23 (p<0.05)***			-1.10 (0.12)		
COMMUNICABLE										
FEMALE	**2003**	61.20	58.61	63.91	18.05	15.67	20.79	18.05	15.67	20.79
	2004	56.67	54.27	59.19	21.87	19.26	24.82	21.87	19.26	24.82
	2005	60.63	58.20	63.18	20.93	18.42	23.78	20.93	18.42	23.78
	2006	54.32	52.07	56.68	19.74	17.36	22.46	19.74	17.36	22.46
	2007	57.61	55.37	59.95	20.14	17.78	22.83	20.14	17.78	22.83
	2008	60.80	58.55	63.15	22.35	19.89	25.13	22.35	19.89	25.13
	2009	55.77	53.63	58.00	18.94	16.73	21.44	18.94	16.73	21.44
	2010	59.62	57.44	61.89	18.04	15.87	20.50	18.04	15.87	20.50
	2011	56.83	54.76	58.99	18.27	16.17	20.64	18.27	16.17	20.64
Slope (p-value)		-0.20 (0.57)			-0.20 (0.38)			-0.73 (0.05)		
MALE	**2003**	114.59	110.25	119.07	33.28	29.55	37.44	24.30	16.27	35.69
	2004	103.21	99.19	107.38	30.69	27.16	34.65	23.38	15.77	34.18
	2005	112.46	108.36	116.70	33.89	30.26	37.92	23.23	16.23	33.13
	2006	105.92	102.06	109.93	33.45	29.87	37.42	21.44	14.55	31.23
	2007	118.43	114.45	122.54	29.48	26.21	33.14	15.24	9.78	23.52
	2008	119.60	115.69	123.65	33.72	30.24	37.57	18.64	12.70	27.21
	2009	111.92	108.22	115.74	29.32	26.14	32.87	16.18	10.92	23.97
	2010	113.84	110.19	117.61	34.05	30.66	37.80	24.64	17.52	34.30
	2011	117.54	113.90	121.29	34.15	30.79	37.86	18.90	12.99	27.25
Slope (p-value)		0.94 (0.21)			0.08 (0.78)			-0.58 (0.23)		

*Significant trends (p<0.05) are indicated in bold

Table S2. Year by year mortality age-standardized mortality rates, regression slopes (annual rate of change) and p-values for all cause mortality, cancer, heart disease, cerebrovascular disease, and communicable diseases by sex and Japanese population (Japan, Foreign-Born, and US-born) for the years 2003-2011.

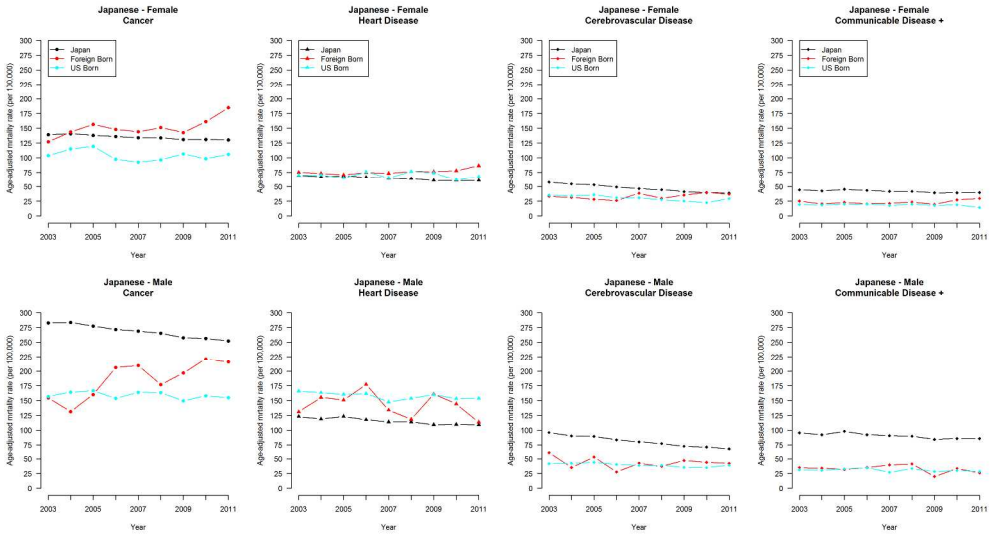
		JAPAN			FOREIGN BORN			US BORN		
ALL CAUSE		**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**
FEMALE	**2003**	428.27	426.87	429.67	378.23	354.32	403.98	333.43	314.28	354.64
	2004	421.76	420.38	423.15	394.92	370.22	421.48	345.80	326.33	367.33
	2005	423.98	422.61	425.36	404.01	379.18	430.70	358.64	338.57	380.78
	2006	411.52	410.18	412.87	397.60	373.27	423.78	349.50	329.90	371.19
	2007	404.82	403.49	406.15	421.44	396.51	448.21	326.74	308.36	347.19
	2008	402.56	401.24	403.87	422.14	397.57	448.52	351.80	332.84	372.83
	2009	388.39	387.10	389.68	435.58	410.66	462.32	360.91	340.98	382.94
	2010	392.71	391.43	393.99	474.60	448.52	502.52	324.85	307.05	344.72
	2011	406.83	405.51	408.15	536.36	508.06	566.52	352.40	333.11	373.80
	Slope (p-value)	**-4.22 (p<0.05)***			**15.99 (p<0.05)**			0.33 (0.86)		
MALE	**2003**	847.69	845.38	850.00	556.58	495.32	624.43	592.63	565.37	621.90
	2004	828.51	826.26	830.77	547.85	486.92	615.42	597.54	570.35	626.73
	2005	836.27	834.04	838.50	627.43	560.55	701.10	613.93	586.15	643.72
	2006	805.57	803.41	807.74	663.32	595.26	738.09	608.71	581.53	637.90
	2007	792.95	790.83	795.08	619.26	553.45	691.81	596.70	569.62	625.80
	2008	786.54	784.45	788.63	590.96	526.95	661.72	600.38	573.30	629.49
	2009	763.39	761.35	765.44	660.87	591.65	736.97	589.55	563.15	617.97
	2010	769.45	767.43	771.48	660.54	592.36	735.52	601.87	574.94	630.83
	2011	772.38	770.37	774.40	599.09	533.90	671.14	600.55	573.50	629.64
	Slope (p-value)	**-10.72 (p<0.05)***			8.38 (0.15)			-0.21 (0.85)		
CANCER										
FEMALE	**2003**	138.91	138.04	139.78	127.12	113.30	142.86	103.72	92.28	117.44
	2004	140.68	139.82	141.56	143.54	128.37	160.66	114.80	102.85	129.01
	2005	137.93	137.08	138.79	156.44	140.68	174.16	119.19	106.74	133.93

	2006	135.81	134.97	136.66	147.85	132.95	164.67	97.35	86.59	110.41
	2007	134.17	133.34	135.02	143.93	129.19	160.60	92.68	81.54	106.19
	2008	133.62	132.79	134.46	151.01	136.14	167.79	96.52	85.88	109.47
	2009	130.78	129.97	131.61	142.71	128.24	159.10	106.51	94.48	120.91
	2010	130.86	130.05	131.68	161.08	145.70	178.37	98.42	87.73	111.42
	2011	130.26	129.44	131.07	184.65	167.83	203.42	105.69	94.32	119.40
	Slope (p-value)	**-1.34 (p<0.05)***			**4.31 (0.02)***			-1.12 (0.35)		
MALE										
	2003	283.04	281.73	284.35	154.55	123.48	192.36	156.97	143.24	172.82
	2004	283.54	282.25	284.84	131.40	103.00	166.59	164.37	150.35	180.49
	2005	277.57	276.31	278.83	160.14	128.31	198.77	166.48	152.13	182.96
	2006	271.81	270.58	273.05	206.05	169.63	249.24	153.79	140.29	169.42
	2007	268.98	267.77	270.19	209.54	172.68	253.20	163.84	149.98	179.81
	2008	265.28	264.10	266.48	177.17	143.58	217.59	163.49	149.34	179.78
	2009	257.57	256.41	258.73	196.60	159.38	240.99	149.59	136.48	164.83
	2010	256.41	255.27	257.56	221.27	183.25	266.13	158.02	144.23	173.97
	2011	252.18	251.06	253.31	215.63	177.85	260.32	154.91	141.27	170.73
	Slope (p-value)	**-4.19 (p<0.05)***			**9.30 (p<0.05)***			-0.86 (0.28)		
HEART DISEASE										
FEMALE	**2003**	69.50	68.99	70.02	74.86	64.80	86.82	70.04	62.59	79.68
	2004	67.23	66.73	67.73	73.41	63.46	85.26	70.13	62.49	79.97
	2005	68.88	68.39	69.39	70.77	61.04	82.40	64.86	57.51	74.46
	2006	66.26	65.77	66.74	74.53	64.58	86.38	75.78	67.15	86.66
	2007	64.54	64.07	65.02	73.13	63.41	84.75	65.22	58.12	74.56
	2008	63.73	63.27	64.20	76.56	66.46	88.58	76.57	68.74	86.63
	2009	60.53	60.08	60.98	76.25	66.39	88.00	74.05	66.39	83.94
	2010	60.92	60.48	61.36	77.77	67.85	89.59	61.72	54.99	70.73
	2011	60.46	60.03	60.90	86.33	75.50	99.10	67.33	60.62	76.29
	Slope (p-value)	**-1.24 (p<0.05)***			**1.20 (0.02)***			-0.28 (0.70)		
MALE	**2003**	122.91	122.04	123.79	130.85	101.79	166.83	165.93	151.76	182.19

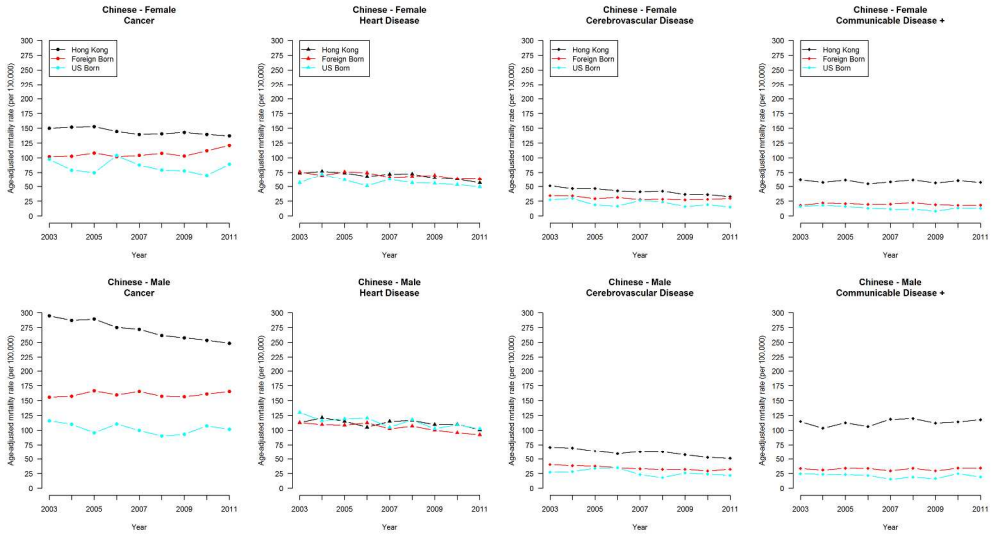
	2004	118.61	117.76	119.46	155.34	122.31	195.55	163.40	149.76	179.12
	2005	123.12	122.27	123.97	150.81	118.08	190.79	160.66	146.99	176.42
	2006	117.54	116.72	118.37	177.30	142.14	219.59	161.88	148.65	177.19
	2007	113.91	113.12	114.72	133.82	104.06	170.65	147.56	134.49	162.76
	2008	113.83	113.04	114.62	118.14	90.21	153.21	153.48	140.44	168.64
	2009	109.18	108.41	109.95	161.01	128.02	201.10	159.99	146.74	175.35
	2010	109.56	108.81	110.32	144.36	113.32	182.51	153.29	139.98	168.73
	2011	109.15	108.40	109.90	113.44	86.31	147.72	153.67	140.50	168.98
	Slope (p-value)	**-1.90 (p<0.05)***			-2.36 (0.46)			-1.49 (0.05)		
CEREBROVASCULAR										
FEMALE	**2003**	57.56	57.08	58.03	33.22	26.41	42.06	35.40	29.81	43.37
	2004	54.41	53.96	54.88	31.33	24.62	40.12	34.08	28.32	42.27
	2005	52.99	52.54	53.44	28.20	21.91	36.57	35.79	29.95	44.05
	2006	49.08	48.65	49.51	26.31	20.04	34.73	30.97	25.51	38.92
	2007	46.52	46.11	46.94	38.57	31.43	47.71	30.51	25.45	38.04
	2008	44.57	44.16	44.97	29.81	23.50	38.19	27.44	22.80	34.58
	2009	41.25	40.87	41.64	35.27	28.61	43.92	25.12	20.92	31.88
	2010	39.59	39.21	39.96	40.08	32.76	49.41	22.60	18.52	29.28
	2011	38.80	38.43	39.17	36.81	29.72	45.95	29.32	24.27	36.92
	Slope (p-value)	**-2.46 (p<0.05)***			0.97 (0.12)			**-1.39 (p<0.05)***		
MALE	**2003**	96.00	95.24	96.77	60.09	41.21	86.07	41.57	35.27	50.12
	2004	90.18	89.45	90.91	35.22	21.52	56.11	42.22	35.85	50.85
	2005	89.51	88.80	90.23	52.80	34.81	78.14	43.90	37.15	52.93
	2006	83.46	82.78	84.15	27.56	14.52	48.63	40.25	34.03	48.75
	2007	80.07	79.41	80.74	42.30	26.55	65.48	38.61	32.57	46.95
	2008	77.33	76.69	77.97	36.88	21.36	60.36	38.83	32.24	47.79
	2009	72.73	72.12	73.35	47.06	30.15	71.43	35.31	29.52	43.45
	2010	71.48	70.88	72.09	43.93	27.54	67.90	35.07	29.06	43.46
	2011	68.24	67.66	68.83	41.93	26.15	65.24	38.92	32.80	47.39

Slope (p-value)		**-3.45 (p<0.05)***			-0.81 (0.55)			**-0.84 (0.01)***		
COMMUNICABLE										
FEMALE	**2003**	44.36	43.97	44.76	25.20	19.55	32.88	19.34	15.47	25.78
	2004	42.41	42.03	42.79	20.40	15.34	27.54	18.44	14.14	25.39
	2005	45.16	44.78	45.55	22.99	17.72	30.30	20.16	15.83	27.10
	2006	43.35	42.98	43.73	20.57	15.75	27.44	20.00	15.11	27.59
	2007	41.86	41.50	42.22	21.31	16.22	28.47	17.84	13.89	24.47
	2008	41.71	41.35	42.07	23.68	18.61	30.75	19.86	15.19	27.23
	2009	39.08	38.74	39.43	19.59	14.92	26.32	17.78	13.26	25.07
	2010	39.26	38.92	39.60	27.31	21.16	35.57	18.82	14.67	25.67
	2011	39.61	39.27	39.95	29.68	23.34	38.10	14.31	11.45	20.00
Slope (p-value)		**-0.70 (p<0.05)***			0.58 (0.21)			-0.40 (0.09)		
MALE	**2003**	95.28	94.54	96.03	34.95	20.69	56.69	31.00	25.09	39.29
	2004	92.11	91.40	92.84	33.84	20.19	54.84	30.39	24.89	38.23
	2005	98.07	97.34	98.80	31.54	17.39	53.65	32.90	26.93	41.24
	2006	92.28	91.59	92.98	35.09	21.14	56.41	34.54	28.66	42.75
	2007	90.61	89.94	91.28	39.56	24.26	62.37	26.87	22.23	33.88
	2008	89.74	89.09	90.40	41.26	23.92	66.95	33.19	27.37	41.38
	2009	84.28	83.66	84.91	19.75	9.36	38.20	28.22	23.34	35.49
	2010	85.71	85.09	86.33	33.55	18.80	56.39	29.95	24.86	37.43
	2011	85.56	84.96	86.18	25.95	13.49	46.49	28.27	23.45	35.49
Slope (p-value)		**-1.47 (p<0.05)***			-0.90 (0.32)			-0.38 (0.28)		

*Significant trends (p<0.05) are indicated in bold



372x203mm (300 x 300 DPI)



372x203mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract – page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found – page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported – pages 4-5
Objectives	3	State specific objectives, including any prespecified hypotheses – page 5
Methods		
Study design	4	Present key elements of study design early in the paper- pages 6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection – pages 6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants – pages 6-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – page 8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group – page 8
Bias	9	Describe any efforts to address potential sources of bias – page 8
Study size	10	Explain how the study size was arrived at – page 9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions - pages 6-8
		(*c*) Explain how missing data were addressed –page 6-7
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy – page 8
		(*e*) Describe any sensitivity analyses –N/A

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed – N/A
		(b) Give reasons for non-participation at each stage – N/A
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders – pages 9-10, Table 1
		(b) Indicate number of participants with missing data for each variable of interest –N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) – N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time –N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure –N/A
		Cross-sectional study—Report numbers of outcome events or summary measures – pages 9-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included –pages 10-12, Table 2
		(*b*) Report category boundaries when continuous variables were categorized – page 10, Table 2
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period –page 12, Figure 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses – page 12
Discussion		
Key results	18	Summarise key results with reference to study objectives –page 12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias –page 16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence –pages 13-17
Generalisability	21	Discuss the generalisability (external validity) of the study results –page 6
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based –page 18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

This checklist has been completed and approved by:

Dr. Latha Palaniappan, MD, MS
Date: 4/8/2016

BMJ Open

U.S. national mortality differences between two Asian subgroups, nativity status, and country of origin from 2003-2011: unveiling disparities through disaggregation

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Keywords:	Cardiac Epidemiology < CARDIOLOGY, EPIDEMIOLOGY, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PUBLIC HEALTH, SOCIAL MEDICINE

Title: U.S. national mortality differences between two Asian subgroups, nativity status, and country of origin from 2003-2011: unveiling disparities through disaggregation

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Keywords: epidemiology; immigrants; health disparities; mortality; Chinese; Japanese

Word count: 3359

ABSTRACT

Background: With immigration and minority populations rapidly growing in the U.S., it is critical to assess how these populations fare after immigration, and in subsequent generations. Our aim is to compare death rates and cause of death across foreign born, U.S. born, and country of origin Chinese and Japanese populations.

Methods: We analyzed all-cause and cause-specific age-standardized mortality rates and trends using 2003-2011 U.S. death record data for Chinese and Japanese decedents aged 25 or older by nativity status and sex, and used the World Health Organization Mortality Database for Hong Kong and Japan decedents in the same years. Characteristics such as age at death, absolute number of deaths by cause, and educational attainment were also reported.

Results: We examined a total of 10,458,849 deaths. All-cause mortality was highest in Hong Kong and Japan, intermediate for foreign-born, and lowest for U.S.-born decedents. Improved mortality outcomes and higher educational attainment among foreign-born were observed compared to developed Asia counterparts. Lower rates in U.S.-born decedents were due to decreased cancer and communicable disease mortality rates in the U.S. Heart disease mortality was either similar or slightly higher among Chinese and Japanese Americans compared to those in developed Asia counterparts.

Conclusion: Mortality advantages in the U.S were largely due to improvements in cancer and communicable disease mortality outcomes. Mortality advantages and higher educational attainments for foreign-born populations compared to developed Asia counterparts may suggest selective migration. Findings add to our limited understanding of the racial and environmental contributions to immigrant health disparities.

STRENGTHS AND LIMITATIONS:

- First study to examine national mortality by disaggregated Asian subgroups and nativity status, in comparison to rates in country of origin using over a decade of data. Lack of country of origin comparisons in previous studies has limited our full understanding of how populations fare after immigration to the U.S.

- U.S. mortality death records may contain errors in the documented cause of death and racial/ethnic misclassification leading to under or over represented cause-specific death rates

- Foreign-born data does not indicate duration of residence, and does not differentiate between naturalized immigrants, permanent residents, nonimmigrants (e.g. temporary workers, students, and visitors), and illegal immigrants.

- Incomplete country comparison groups for the Chinese population (Hong Kong) as available in the WHO mortality database may limit our interpretations. However, this segmented Chinese population better controls for differences in level of economic development and access to medical technologies, etc.

INTRODUCTION

Epidemiologic transitions are well underway in developing countries, and patterns of disease are beginning to reflect those seen in developed countries. Non-communicable diseases such as cardiovascular disease (CVD) and cancers are now the leading causes of death around the world, accounting for 68% (38 million) of all deaths globally in 2012, an increase from 60% (30 million) in 2000.[1] While widely studied in native populations, our understanding of disease patterns in diverse and immigrant populations is limited. Worldwide, immigration rates are increasing at unprecedented rates, with global immigrant population projections estimated to double in size to 405 million by 2050,[2] yet little research explores how nativity status (foreign-born vs. native born) may play a role in health or mortality risk factors. Prior evidence has documented serious health disparities between immigrant populations and host populations, with many immigrants experiencing significantly worse health outcomes and disproportionately suffering from heart attacks, cancer, diabetes, strokes, and HIV/AIDS compared to native populations.[3]

Host and sending countries differ, as do the self-selection of immigrants; poor immigrants fleeing violence and poverty differ from professionals migrating for education and career opportunities. Given the lack of data quantifying immigrant health in national databases (i.e. lack of acculturation proxies, undocumented immigrants, language barriers during data collection, unrepresentative, etc.), studies find inconsistent conclusions regarding health risks in host countries. For example, some studies describe lower CVD risks and mortality among recent immigrants to developed countries compared to long-term immigrants[4-6]; others describe increased risks.[7-9] The “Healthy Migrant Effect”[10] posits that on many measures, new immigrants are healthier than average for the sending country, and may also be healthier than

subsequent generations who share similar ethnic or racial backgrounds in the host country. This selective migration reflects both that migrants are often of higher socioeconomic status (SES) than the average population of the sending country (despite lower socioeconomic positions within the host country), as well as of better health conditional on SES.[11]

However, even healthy immigrants from developing countries have been exposed to a different disease environment in childhood than those born in developed countries, and may be more prone to communicable diseases and infection-induced cancers. These conflicting factors suggest that immigrants may have worse or better health than host populations in the U.S. or other high-income countries, in addition to facing other known risk factors of immigration such as restricted health care access, language barriers, lower relative SES, discrimination, and more. Additionally, data are severely lacking among specific racial/ethnic immigrant groups, such as Asian subgroups.

Asian populations constitute over 60% of the world's population (4.4 out of 7.3 billion people).[12] Asians are the fastest growing racial/ethnic group in the U.S. and are projected to double in size to over 34 million by 2060.[13] Recent data disaggregated by individual subgroups has raised awareness about morbidity and mortality risks that impact certain Asian Americans disproportionately[14-17], but none have explored these differences by nativity status in comparison to sending country. Our study focuses on two specific Asian American subgroups, Chinese and Japanese. Census data from 2011 show that Chinese Americans are nearly five times greater than the Japanese American population (3,520,150 vs. 756,898, respectively).[18] Differences in immigration histories, as described in separate study[19], have resulted in almost twice as many Chinese immigrants than Japanese immigrants in recent decades (70% vs. 39%, respectively) with settlements in different regions throughout the U.S.

Subgroups are also genetically, culturally, and behaviorally diverse, which may affect mortality risks.

The purpose of this study is to 1) examine decedent characteristics and cause of death differences by nativity (foreign-born vs. U.S. born) for Chinese and Japanese Americans to capture heterogeneity between two commonly aggregated racial/ethnic groups, 2) to compare outcomes to country of origin to observe how mortality burden shifts upon immigration to the U.S, and 3) to report mortality trends from 2003-2011. To our knowledge, this is the first study of its kind. These comparisons will add to our understanding of the racial and environmental contributions to immigrant health disparities in support of improved research agendas, clinical guidelines, and health policies.

METHODS

U.S. study population

We examined U.S. national mortality records from the National Center for Health Statistics' (NCHS) Multiple Cause of Death files from years 2003-2011. Decedents represent non-Hispanic Chinese and Japanese populations as identified on the death records by a funeral director using national guidelines. All analyses are confined to individuals aged 25 years or older to account for potential data limitations in accounting for competing risks (i.e. maternal/infant mortality) in cross-country comparisons. All 50 states and the District of Columbia were included in the analysis, thus results are generalizable.

Year of death, age, location of death, nativity status (foreign-born and U.S born), race/ethnicity of the decedent and the underlying cause of death (disease or injury that initiated the events resulting in death) were identified from death certificates. Note that the foreign-born variable only indicates, "born outside of the United States", and does not provide country of birth

details. "Underlying cause of death" was coded by NCHS using the International Classification of Diseases, 10th revision (ICD-10). Year by year population estimates were calculated from the 2000 and 2010 U.S. Census data using linear interpolation for 2003-2009 and extrapolation for 2011. To evaluate the appropriateness of the linear interpolation approach, we used American Community Survey (ACS) data to plot total U.S. population by year in each group of interest and none of these plots appeared to show a consistent departure from linearity. Additionally, to calculate population estimates by nativity status, we used the Public Use Microdata Sample (PUMS) from the 5-year 2005-2009 ACS database to determine proportions of foreign-born populations for each Asian subgroup, age-group, and sex by state and aggregated those numbers to the nation. For ACS, use of 5-year data is required to provide complete coverage, and the 2005-2009 data are the earliest available and also cover the middle 5 years out of 9 included. However, analyses of individual years will be affected by changes in the percentages of foreign-born and U.S.-born. We adjusted the estimates of percent foreign-born using a linear adjustment based on the overall change in foreign-born from the 2000 and 2010 U.S. censuses.

Chinese and Japanese counterparts in developed Asia

To compare Asian-American mortality to that of ethnic counterparts living in developed Asia, we examined decedent-level mortality records from Hong Kong and Japan from the World Health Organization (WHO) Mortality Database from 2003-2011 which can be obtained from their website (http://www.who.int/healthinfo/mortality_data/en/). Although Chinese Americans may come from a range of regions (PRC, Hong Kong, Macao, Taiwan, southeast Asia), we selected Hong Kong as representative of ethnic Chinese living in developed Asia because of Hong Kong's high quality cause-specific mortality data and similarities in potential conditions

shaping health outcomes (affluence, urbanization, healthcare, etc.). Since Hong Kong has among the best survival rates of all China's cities/provinces[20], this comparison helps to isolate the differences associated with lifetime exposure to an earlier phase of the epidemiologic transition among Chinese living in Asia, rather than current living standards. Whole country data for Japan was available and used for comparison to Japanese American decedents. Average annual population estimates by age and sex from the WHO database were used to calculate age-standardized mortality rates.

Statistical Analysis

The following causes of death (ICD-10 codes) were chosen as outcome variables: All Cause, All Cancer (C00-C97), Heart Disease (I00-I09, I13, I20-I51), Cerebrovascular Disease (I60-I69), Communicable diseases, maternal, and nutritional conditions (A00-B99, G00-G04, N70-N73, J00-J06, J10-J18, J20-J22, H65-H66, O00-O99, P00-P96, E00-E02, E50, D50-D53, D64.9, E51-E64), Influenza and pneumonia (J09-J18), Alzheimer's Disease (G30), Accidents (V01-X59, Y85-Y86), and Chronic Lower Respiratory Diseases (J40-J47). The classification scheme used to categorize all 358 causes of deaths was selected to encompass the leading causes of death in both the U.S. and developed Asia, including the primary non-communicable diseases as well as an aggregated communicable disease category.[21] For both WHO and U.S. data, we calculated raw mortality rates for these categories by summing death counts for each category in the year (for year-by year analyses) or nine years (for composite analyses) and dividing by the corresponding population to produce age, race, sex, cause-specific raw mortality rates. We used direct age-standardization with the 2000 WHO Standard Population to calculate mortality rates for each group of interest.[22]

RESULTS

We examined a total of 10,458,849 (352,822 in Hong Kong, 9,959,489 in Japan, and 146,538 in the U.S.) deaths from 2003 to 2011. One of our first objectives was to observe decedent characteristics between U.S. Chinese and Japanese populations, compared to developed Asia counterparts, as shown in Table 1. In general, females constituted about half of each sub-group, with the exception of foreign-born Japanese (78% females). The median age of death was also similar across Chinese subgroups, around 80 years old, whereas Japanese had a seven-year difference in median age of death between U.S.-born and foreign-born decedents (84 years old vs. 77 years old, respectively). Among both Chinese and Japanese, foreign-born decedents have received more education than the adult populations in developed Asia, as measured by rates of high school completion, and U.S.-born decedents attained either similar (among Japanese) or higher rates of high school completion (Table 1). Among Chinese Americans, "less than secondary (high school) completed" was 21% for U.S.-born vs. 41% for foreign-born, and "secondary completed" was 52% for U.S born vs. 35% for foreign-born. Educational attainment was similar for Japanese-Americans, regardless of nativity; but over 60% of Japanese-American decedents had completed high school, compared to only 38% of the Japan population.

Table 1. Decedent characteristics using death record data for Chinese and Japanese populations in the U.S. and in developed Asia counterparts (Hong Kong and Japan), 2003-2011.

	Chinese			Japanese		
	Hong Kong	Foreign born	U.S. Born	Japan	Foreign-born	U.S. Born
Characteristics						
Female (%)	44	48	46	46	78	47
Age at death						
25-44	14,344	2,843	579	244,460	445	600
45-64	58,852	12,211	1,716	1,341,391	2,118	4,174
65-74	65,330	12,324	1,197	1,772,960	3,437	4,373
75-84	115,505	23,306	3,064	3,118,854	6,114	13,941
85+	98,791	27,274	3,740	3,481,824	2,517	20,565
Median age at death	78	80	81	80	77	84

Total number of deaths	352,822	77,958	10,296	9,959,489	14,631	43,653
Avg. population size	5,087,389	1,805,385	316,337	95,717,355	260,884	371,188
Absolute numbers of deaths due to						
Cancer	111,090	24,841	2,657	3,012,577	4,913	9,837
Heart Disease	54,964	18,019	2,806	1,631,231	2,791	11,284
Cerebrovascular Diseases	30,958	6,569	805	1,144,770	1,103	3,726
Communicable, maternal, and nutritional conditions	54,162	5,373	571	1,245,295	813	2,565
Influenza and Pneumonia	43,910	3,427	343	990,576	357	1,697
Alzheimer's Disease	102	1,473	242	25,988	430	1,545
Accidents	6,612	2,517	392	363,844	567	1,277
Chronic Lower Respiratory Diseases	18,541	2,866	238	172,038	468	1,226
Education Attainment						
Less than secondary completed	52.4*	41.0	21.0	42.9*	17.0	21.0
Secondary (high school) Completed	29.0*	35.0	52.0	37.9*	66.0	63.0
Tertiary (college) Completed	18.6*	24.0	27.0	19.2*	17.0	16.0

*International education attainment (i.e. Hong Kong and Japan) was obtained from Barro-lee Educational Attainment dataset, based on the population in 2005 (approximate mid-year) for individuals aged 25+; data can be retrieved at: http://barrolee.com/; individual-level educational data not available within W.H.O mortality records.

Consistent with 2010 Census population data[23], a much larger proportion of Chinese American decedents was foreign-born, whereas for Japanese American decedents a larger proportion was U.S.-born. According to the absolute number of deaths due to a specific cause (Table 1), cancer ranked as the top cause of death for foreign-born and developed Asia decedents in each of the subgroups (when females and males are aggregated), but heart disease ranked as the leading cause for all U.S.-born counterparts. Cerebrovascular disease ranked third for both the U.S.-born and foreign-born Asian American subgroups, but ranked 4th (with communicable diseases ranking as 3rd) for countries of origin.

Next, we sought to observe differences in cause of death for Chinese and Japanese Americans, and compare rates to developed Asia counterparts as shown in Table 2 and Figure 1. All-cause mortality rates were highest in Hong Kong (434 per 100,000 for females, 783 for males) and Japan (408 for females, 799 for males), intermediate for foreign-born Chinese-(319

for females, 468 for males) and Japanese-Americans (429 for females, 614 for males), and lowest for U.S.-born Chinese (260 for females, 383 for males) and Japanese (345 for females, 600 for males) (Table 2). Overall death rates are lower in U.S. born decedents compared to countries of origin, and this is largely due to the difference in cancer deaths in the U.S. for both Chinese and Japanese compared to developed Asia counterparts. Heart disease rates were either similar or slightly higher among Chinese and Japanese in the U.S. compared to those in Asia, with a higher mortality burden from heart disease for U.S born decedents. Mortality rates for communicable diseases were much higher in Asia. The Central Illustration (Figure 1) pictorially demonstrates mortality differences among subgroup populations (ethnicity, nativity status, sex) by top causes of death.

Table 2. Age-adjusted mortality rates with 95% confidence intervals by top causes of death for Chinese and Japanese populations in the U.S. and living in Asia (2003-2011). Data based on individuals aged 25+ years.

			Asia	U.S.	
			Hong Kong	Foreign-born	U.S.-born
FEMALE		**Cause of Death**	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**
	Chinese	All cause	434.4 (432.1-436.7)	319.0 (315.7-322.3)	260.3 (252.2-268.6)
		Cancer	143.9 (142.5-145.3)	107.2 (105.2-109.2)	84.1 (79.1-89.3)
		Heart Disease	68.5 (67.6-69.4)	69.4 (67.9-70.9)	57.2 (53.6-60.9)
		Cerebrovascular Diseases	41.1 (40.4-41.8)	29.9 (28.9-30.9)	21.1 (18.9-23.5)
		Communicable, maternal, and nutritional conditions	58.2 (57.4-58.9)	19.8 (19.0-20.6)	13.3 (11.6-15.2)
		Influenza and Pneumonia	46.1 (45.5-46.8)	12.1 (11.5-12.7)	7.7 (6.5-9.2)
		Alzheimer's Disease	0.1 (0.1-0.2)	6.9 (6.5-7.4)	6.1 (5.2-7.4)
		Accidents	6.5 (6.2-6.8)	10.2 (9.6-10.9)	9.1 (7.6-10.8)
		Chronic Lower Respiratory Diseases	12.8 (12.5-13.2)	7.2 (6.7-7.7)	5.1 (4.0-6.4)
			Japan		
	Japanese	All cause	408.4 (408.0-408.9)	429.0 (420.6-437.7)	344.9 (338.4-351.6)
		Cancer	134.7 (134.4-135.0)	150.8 (145.7-156.2)	103.9 (100.0-108.0)
		Heart Disease	64.5 (64.3-64.7)	75.9 (72.5-79-5)	69.5 (67.0-72.3)
		Cerebrovascular Diseases	46.7 (46.5-46.8)	33.3 (30.9-35.8)	30.2 (28.4-32.2)
		Communicable, maternal, and nutritional conditions	41.7 (41.6-41.9)	23.4 (21.5-25.5)	18.5 (17.1-20.2)
		Influenza and Pneumonia	30.4 (30.3-30.5)	9.7 (8.5-11.1)	9.9 (8.9-11.0)
		Alzheimer's Disease	1.1 (1.1-.1.1)	13.8 (12.4-15.4)	9.7 (9.0-10.6)
		Accidents	15.4 (15.3-15.5)	15.8 (14.1-17.8)	10.6 (9.2-12.2)
		Chronic Lower Respiratory Diseases	4.0 (4.0-4.0)	13.1 (11.8-24.6)	6.8 (6.0-7.9)
			Asia	**U.S.**	
MALE			**Hong Kong**	**Foreign-born**	**U.S.-born**
		Cause of Death	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**
	Chinese	All cause	783.0 (779.5-786.5)	468.1 (463.5-472.6)	383.2 (372.6-394.0)
		Cancer	269.7 (267.6-271.7)	160.6 (157.9-163.3)	102.1 (96.6-108.0)

	Heart Disease	111.0 (109.7-112.3)	103.9 (101.7-106.0)	112.8 (107.1-118.8)
	Cerebrovascular Diseases	60.2 (59.2-61.1)	34.1 (32.9-35.4)	26.0 (23.4-29.0)
	Communicable and nutritional conditions	113.4 (112.1-114.6)	32.5 (32.0-33.7)	20.5 (18.2-23.1)
	Influenza and Pneumonia	90.8 (89.7-92.0)	20.0 (19.1-21.0)	11.1 (9.4-13.0)
	Alzheimer's Disease	0.2 (0.1-0.2)	5.3 (4.9-5.8)	5.2 (4.2-6.5)
	Accidents	20.2 (19.6-20.8)	17.7 (16.8-18.7)	16.0 (13.9-18.4)
	Chronic Lower Respiratory Diseases	51.0 (50.1-51.9)	21.4 (20.5-22.4)	9.4 (7.8-11.2)
		Japan		
Japanese	All Cause	799.1 (798.3-799.8)	613.8 (591.5-636.8)	600.2 (591.1-609.5)
	Cancer	268.2 (267.8-268.6)	185.6 (173.6-198.3)	159.1 (154.4-164.0)
	Heart Disease	115.0 (114.8-115.3)	142.9 (132.1-154.4)	157.8 (153.3-162.5)
	Cerebrovascular Diseases	80.2 (80.0-80.4)	43.1 (37.3-49.7)	39.4 (37.3-41.8)
	Communicable and nutritional conditions	90.1 (89.8-90.3)	32.9 (27.7-38.8)	30.6 (28.7-32.7)
	Influenza and Pneumonia	71.1 (70.9-71.3)	21.2 (17.0-26.3)	18.8 (17.4-20.3)
	Alzheimer's Disease	1.3 (1.2-1.3)	9.7 (6.9-13.4)	9.7 (8.8-10.7)
	Accidents	36.4 (36.2-36.6)	33.2 (28.5-38.6)	26.5 (24.2-29.1)
	Chronic Lower Respiratory Diseases	16.0 (15.9-16.1)	15.4 (11.8-19.8)	18.3 (16.9-20.0)

Finally, we examined mortality trend data from 2003-2011 in the U.S, Hong Kong, and Japanese for Chinese and Japanese populations, as shown in Figure 2. Notably, Chinese trends indicate that mortality rates steadily decreased in Hong Kong since 2003 (APC for F: -10.5, $p<0.05$; M: -6.0, $p<0.05$). Japanese all-cause rates have decreased in Japan over the study period as well (F: -4.2, $p<0.05$; M: -10.7, $p<0.05$)(Table S2). Mortality rates by year with 95% CIs and annual percent change (APC) estimates with p-values (Table S1, S2) and cause-specific mortality rates (Figure S1, S2) were presented as supplemental data. Cancer, heart disease, and cerebrovascular diseases decreased in Hong Kong for females and males (Figure S1). The same is true for Japan, in addition to communicable diseases (Figure S2). Conversely, cancer mortality increased by 2% for Chinese and 4% for Japanese foreign-born females, and 9% for Japanese foreign-born males (Table S1, S2).

DISCUSSION

Our study aimed to disaggregate national mortality data by Asian American subgroup (Chinese and Japanese), nativity status (foreign-born vs. U.S.-born), sex, and country of origin to

capture cause of death heterogeneity between groups. Incorporating country of origin data also provides a holistic overview of how certain populations may fare upon immigration in the U.S. The study also aimed to report mortality trends to understand where improvements may or may not be occurring for each population. We showed that U.S.-born Asians have better mortality outcomes than foreign-born Asians, an opposite effect to what has been observed among Hispanic/Latinos in the U.S.[24] Furthermore, our study showed better mortality outcomes and higher educational attainment for foreign-born counterparts compared to populations in native countries, suggestive of selective migration. We explored cause-specific mortality to provide insight into where most of these mortality gains were made, largely from improvements in cancer mortality in the U.S.-born group when compared to decedents in countries of origin.

Population level and infrastructural differences that support or undermine health may contribute to observed mortality patterns. For example, the mortality advantage among Asians in the U.S. (foreign-born and U.S.-born) compared to Hong Kong and Japan is likely explained by decreased exposures to communicable diseases in these countries.[25] Selective migration may also help explain the observed attenuation in foreign-born mortality rates and increased education attainment levels compared to developed Asia counterparts. A "healthy" migrant does not exclusively indicate an advantage over U.S.-born and/or majority populations, but rather how they fare in comparison to sending countries as well. Mexican migrants to the U.S. have shown not to be a selected group of their country of origin (i.e. Mexico), unlike migrants from other distant countries such as in Asia.[26]

The mortality advantage for U.S.-born decedents compared to foreign-born counterparts may be largely attributed to inadequate access to health care and health insurance for immigrant populations according to the Migration Policy Institute.[27] Their analyses using Census data

show that immigrants were more than three times as likely to be uninsured (44%) as native-born citizens (13%). According to 2008-2010 ACS data, one study found that certain Asian American subgroups, such as Chinese and Japanese, were on the lower end of the uninsured population, with Japanese at 7% and Chinese at 14%, compared to the national average of 16%.[28]. This same study showed that Asians with larger percentages of native-born populations were less likely to be uninsured.

Our study has also shown that different causes of death were more important for each subgroup. Increased cancer mortality rates in foreign-born groups compared to U.S.-born are likely caused by higher exposure levels to communicable/infectious diseases in countries of origin[25] and lack of access to preventive screenings for early detection due to higher uninsured rates among foreign-born populations.[28]. Liver cancer has shown to be more important for Chinese immigrants, which likely reflects the high rates of chronic Hepatitis B virus in certain Asian countries, such as China and Vietnam.[29] Other studies have demonstrated that stomach cancer mortality rates are higher for foreign-born Japanese, reflecting the influence of rates of Helicobacter pylori infection and traditional dietary intake of pickled and salted foods.[30, 31]

Increased heart disease mortality rates among Japanese men, and an overall greater proportion of heart disease deaths among all U.S.-born subgroups, may be attributed to acculturation and increased CVD risk factors as illustrated by the landmark Ni-Hon-San study.[32, 33] The Honolulu Heart Program (HPP) evaluated CVD among Japanese men living in Honolulu within the Ni-Hon-San cohort and showed that risk factor levels of those men had risen to levels comparable to non-Hispanic whites (NHWs).[34] However, stroke and coronary heart disease had remained lower than for non-Hispanic whites. The children of HHP study participants were also followed, and investigators found that BMI and diabetes prevalence were

substantially higher in children compared to their fathers, however total cholesterol was lower in children.[35] These observations suggest that acculturation such as adopted dietary and lifestyle behaviors similar to majority populations in the U.S. contribute to changes in CVD risk factors (i.e. increased BP and decreased smoking and alcohol intake) and, subsequently, increased heart disease and decreased stroke mortality, respectively, as also shown in our findings.

Previous studies of foreign-born aggregated Asian Americans have shown lower rates of all-cause mortality compared to their U.S.-born counterparts[36], consistent with health outcomes demonstrated among Hispanic/Latino immigrants in the U.S.[37] As we begin to disentangle ambiguities in mortality outcomes by Asian subgroup, we show that such patterns are not equally reflected among all groups. A similar study disaggregating Asian Americans by foreign- and U.S.-born decedents showed that while Asian Indian, Korean, and Vietnamese foreign-born populations had lower all-cause mortality rates and a higher life expectancy than U.S.-born counterparts, the opposite was true for Chinese, Filipino, and Japanese immigrants.[30] More research must be done to investigate the forces that lead to large variations between immigrant groups in the U.S., and how the health of immigrant children may differentiate from their own (i.e. generational differences). One study speculated that health advantages over other ethnicities might accrue with longer histories of settlement in the U.S. like with Japanese and Chinese Americans.[38] Such analyses may provide important clues as to what degree socio-environmental contexts may play over genetic risk factors in immigrant health.

Limitations include the use of the U.S. mortality death records, which may contain errors in the documented cause of death and racial/ethnic misclassification leading to under or over represented cause-specific death rates.[39] We acknowledge that the sample for Japanese

foreign-born men (approx. 3,200 decedents, or 22% of Japanese foreign-born) is small, which may limit our interpretation for direct comparisons with other subgroups. The gender imbalance in Japanese migration to the U.S. has been previously explained by the influx of "war brides" from 1952-1960, whereby Japanese women entered the U.S. as wives and fiancées of American military personnel.[40] Additionally, foreign-born data does not indicate duration of residence, and does not differentiate between naturalized immigrants, permanent residents, nonimmigrants (e.g. temporary workers, students, and visitors), and illegal immigrants, limiting our interpretations.[10] Comparability of the U.S. and international mortality databases may be compromised due to differences in reporting and coding practices by country. To minimize this uncertainty, authors chose to emphasize causes for which we had reason to believe coding was similar (cardiovascular, cancer, communicable disease), and acknowledge that some causes, such as Alzheimer's Disease[41], may vary substantially. Incomplete country comparison groups for the Chinese population (Hong Kong) as available in the WHO mortality database may limit our interpretations. However, this segmented Chinese population better controls for differences in level of economic development and access to medical technologies, etc. Population sizes are estimated rather than known, so the precision of age-standardized mortality rates may be less than expected and the confidence intervals too narrow.

From a theoretical standpoint, it is important to consider that all-cause mortality rates among foreign-born groups may be underestimated by reverse migration causing "statistical immortality". This arises if immigrants leave the U.S. in old age and die in other countries without dropping appropriately from the U.S. Census denominator. Reverse migration may be highly selective, with sicker immigrants more inclined to return to their country of origin if and when they cannot work, and for those with chronic (rather than sudden) causes of death. A recent

study found selective reverse migration to be true among Mexican migrants in the U.S., with higher probabilities of Mexican migrants in poor health to return home (and lower probabilities of return in improving health).[42] Statistical immortality may differ by Asian subgroup, given possible differences in ease of return migration. For instance, it may be easier for U.S. citizens to return migrate to Japan rather than China, given the more favorable visa and citizenship requirements.[43, 44] There are also more social protection systems for the elderly in Japan[45] [46], compared to China[47]. The exact numbers of return migrants from the U.S. to these respective countries is unknown.

Traditionally, mortality analyses are a valid indicator of a population's health status, yet our findings warrant further investigation upon the socioeconomic indicators impacting mortality outcomes, other health risk factors, and health care utilization differences between foreign-born and U.S.-born counterparts. In effort to improve current targeted prevention strategies for racial/ethnic minorities, our data suggest that heart disease risk factor modification is more important for U.S.-born Chinese and Japanese (similar to majority population) than foreign-born counterparts. Cancer screenings may be more important for foreign-born Chinese and Japanese, such as screening for gastric cancer and liver cancer (infection-induced cancers).

A substantial knowledge gap exists on this topic largely because comparing mortality rates across countries is complex given the differences in disease definitions, racial/ethnic classifications, numbers of years for which data are available, and methods of standardization. Accounting for these limitations, our analyses provide an empirical basis for understanding health disparities among two diverse Asian immigrants in the U.S, compared to developed Asia counterparts. The main findings of our study highlight the importance that not only race/ethnicity

plays, but also nativity status, in unveiling mortality disparities for minority populations in the U.S.

FIGURE LEGENDS

Figure 1. Central Illustration: Age-adjusted mortality rates for Chinese and Japanese populations by top causes of death (cancer, heart disease, cerebrovascular disease, and communicable diseases); combined study years (2003-2011).

Figure 2. Year by year all cause age-adjusted mortality rates plotted from 2003-2011 for Chinese and Japanese populations by sex.

Figure S1. Year by year cause-specific age-adjusted mortality rates (cancer, heart disease, cerebrovascular disease, and communicable disease) plotted from 2003-2011 for Chinese populations by sex.

Figure S2. Year by year cause-specific age-adjusted mortality rates (cancer, heart disease, cerebrovascular disease, and communicable disease) plotted from 2003-2011 for Japanese populations by sex.

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CONTRIBUTORSHIP STATEMENT

KGH and KE designed the analytic plan and formulated research questions/hypotheses. KK and DB data cleaned, analyzed the data, and generated figures. KE, MB, MC, LP provided content expertise and critical overview of the various drafts. MC and LP are study co-principal investigators. All authors were involved in interpreting findings and revising the first draft, which was written by KGH. All authors approved the final draft of the manuscript.

COMPETING INTERESTS

No financial disclosures or competing interests to disclose.

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DATA SHARING

No additional data available.

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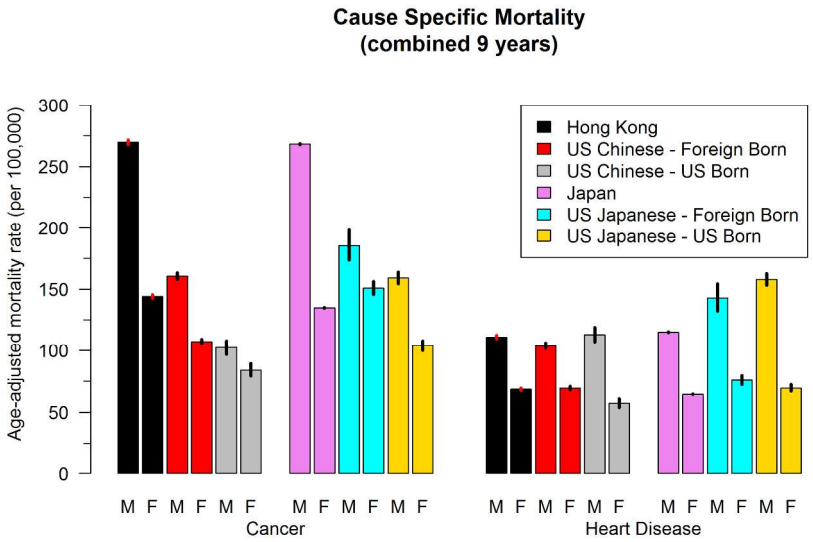

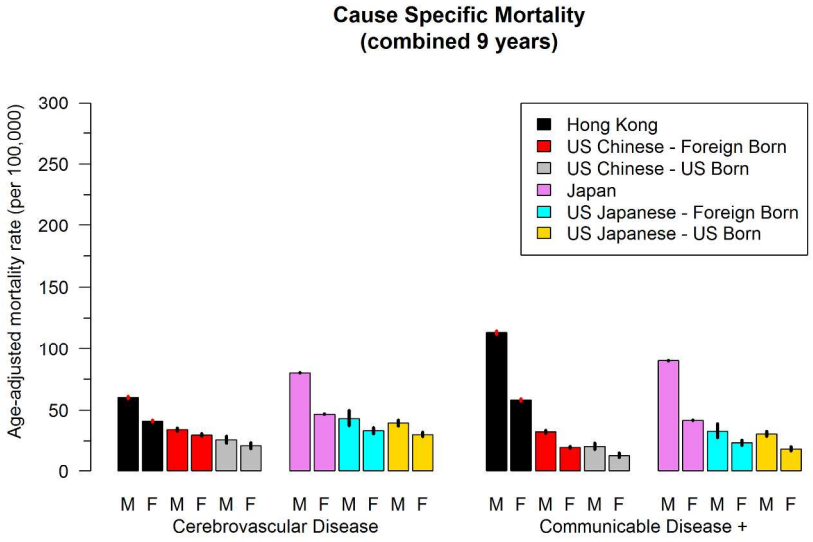

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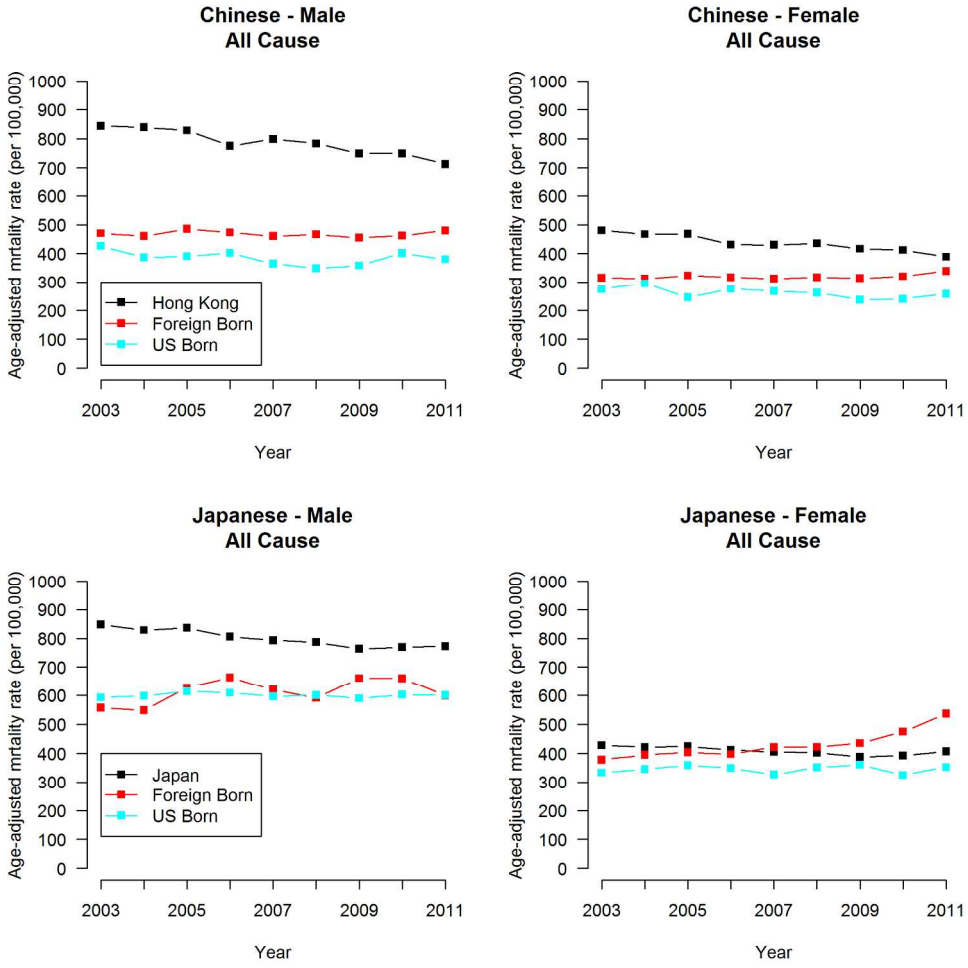

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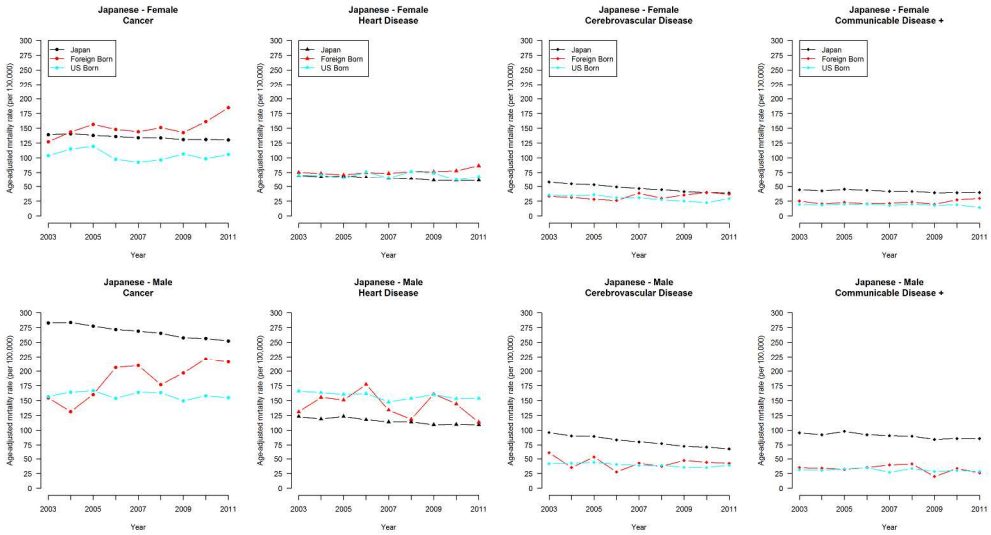

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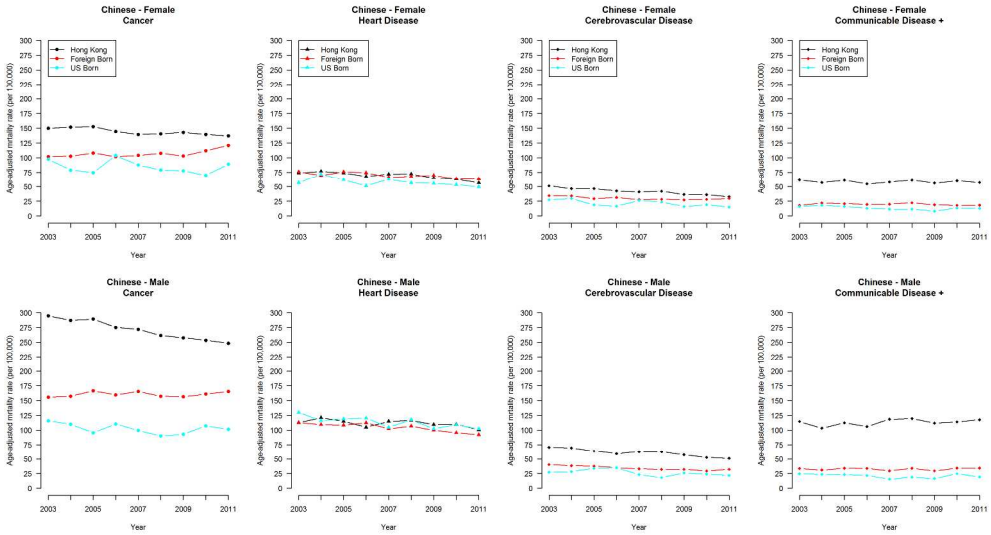

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SUPPLEMENTARY DATA

Table S1. Year by year mortality age-standardized mortality rates, regression slopes (annual rate of change) and p-values for all cause mortality, cancer, heart disease, cerebrovascular disease, and communicable diseases by sex and Chinese population (Hong Kong, Foreign-Born, and US-born) for the years 2003-2011.

		HONG KONG			FOREIGN BORN			US-BORN		
ALL CAUSE		**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**
FEMALE	**2003**	480.32	472.51	488.25	314.94	304.41	325.82	274.85	246.33	304.64
	2004	467.25	459.69	474.92	312.07	301.79	322.69	294.80	265.33	324.82
	2005	467.69	460.27	475.23	323.30	312.98	333.95	245.26	219.33	271.48
	2006	430.90	423.88	438.03	316.58	306.53	326.95	275.06	247.30	302.54
	2007	429.98	423.15	436.92	312.00	302.18	322.12	266.77	240.52	293.24
	2008	435.41	428.67	442.25	316.75	307.05	326.76	261.63	236.42	287.05
	2009	416.55	409.99	423.20	313.34	303.85	323.13	236.55	214.94	260.29
	2010	412.19	405.79	418.69	320.43	310.92	330.23	239.80	218.41	263.25
	2011	388.96	382.86	395.16	338.68	329.03	348.61	257.35	235.18	281.55
	Slope (p-value)	**-10.47 (p<0.05)***			1.67 (0.13)			-4.43 (0.06)		
MALE	**2003**	843.97	832.22	855.86	470.07	455.49	485.09	426.50	390.13	465.93
	2004	838.96	827.45	850.62	460.49	446.32	475.07	386.44	352.71	423.09
	2005	828.35	817.14	839.70	485.26	470.93	500.00	390.37	357.97	425.51
	2006	774.99	764.36	785.76	473.29	459.35	487.63	402.06	369.47	437.31
	2007	798.80	788.25	809.48	460.43	446.92	474.31	364.61	334.21	397.58
	2008	783.53	773.26	793.94	466.40	453.02	480.15	348.49	319.55	379.87
	2009	749.35	739.46	759.36	455.13	442.10	468.53	358.16	328.57	389.97
	2010	749.44	739.73	759.27	462.28	449.30	475.62	401.12	370.84	433.69
	2011	713.06	703.75	722.49	479.69	466.67	493.05	380.00	351.40	410.80
	Slope (p-value)	**-15.69 (p<0.05)***			-0.39 (0.78)			-4.33 (0.19)		
CANCER										
FEMALE	**2003**	149.78	145.17	154.53	101.78	95.59	108.34	97.40	80.67	117.62
	2004	151.75	147.20	156.43	102.58	96.48	109.05	79.07	64.89	96.66

	2005	152.56	148.06	157.20	108.11	101.93	114.63	74.83	61.51	91.18
	2006	144.30	139.99	148.74	101.91	96.00	108.15	103.68	87.83	122.70
	2007	139.47	135.30	143.75	103.95	98.07	110.15	87.72	72.52	105.12
	2008	140.40	136.29	144.63	107.75	101.87	113.96	79.41	66.98	95.16
	2009	142.97	138.86	147.19	102.95	97.30	108.92	77.91	64.88	93.55
	2010	139.42	135.43	143.51	111.78	105.94	117.92	70.11	55.63	84.82
	2011	137.04	133.13	141.04	120.94	114.92	127.25	89.04	74.24	105.19
	Slope (p-value)	**-1.85 (p<0.05)***			**1.66 (0.03)***			-1.11 (0.39)		
MALE										
	2003	294.78	287.90	301.80	155.86	147.42	164.73	115.77	98.30	137.97
	2004	286.97	280.29	293.80	157.22	148.88	165.97	109.84	91.38	131.22
	2005	289.27	282.67	296.00	166.45	158.00	175.31	95.43	79.45	114.64
	2006	275.14	268.82	281.60	159.65	151.51	168.20	110.41	93.32	130.76
	2007	272.20	266.04	278.50	165.31	157.16	173.84	99.39	83.68	118.25
	2008	261.51	255.54	267.60	157.35	149.51	165.56	90.10	75.58	107.18
	2009	257.82	252.00	263.77	156.29	148.59	164.34	92.85	77.99	110.35
	2010	253.57	247.90	259.37	161.03	153.32	169.09	107.18	91.33	125.46
	2011	248.34	242.79	254.01	165.24	157.52	173.31	101.46	86.71	118.85
	Slope (p-value)	**-6.04 (p<0.05)***			0.44 (0.46)			-1.51 (0.20)		
HEART DISEASE										
FEMALE	**2003**	73.81	70.90	76.85	76.08	71.14	81.37	56.51	45.80	69.92
	2004	76.94	74.01	79.98	69.61	64.99	74.56	71.68	59.71	86.67
	2005	73.88	71.07	76.80	76.00	71.24	81.09	61.58	50.16	75.58
	2006	68.11	65.46	70.86	74.36	69.73	79.30	51.01	41.44	62.96
	2007	71.75	69.10	74.51	66.35	62.04	70.96	62.46	51.56	75.72
	2008	72.31	69.72	75.00	67.90	63.63	72.46	56.18	46.21	68.39
	2009	64.88	62.43	67.43	69.80	65.55	74.34	55.43	45.84	67.39
	2010	62.93	60.56	65.38	63.66	59.65	67.95	53.11	44.20	64.16
	2011	56.30	54.12	58.58	63.14	59.19	67.35	49.55	40.84	60.73
	Slope (p-value)	**-2.10 (p<0.05)***			**-1.49 (0.04)***			-1.51 (0.08)		

MALE	**2003**	112.71	108.45	117.12	112.42	105.45	119.83	130.00	110.27	152.63
	2004	120.86	116.53	125.33	109.31	102.54	116.49	115.94	97.74	137.16
	2005	114.80	110.67	119.08	108.46	101.81	115.51	119.02	101.36	139.50
	2006	104.81	100.93	108.82	112.28	105.62	119.33	120.30	103.02	140.15
	2007	114.75	110.80	118.83	102.24	96.00	108.85	104.66	88.57	123.29
	2008	116.37	112.47	120.40	106.71	100.42	113.37	117.57	100.75	136.93
	2009	109.40	105.67	113.25	99.64	93.65	106.00	102.40	86.89	120.18
	2010	109.56	105.89	113.36	95.48	89.72	101.60	109.13	93.59	127.04
	2011	100.75	97.30	104.32	92.10	86.53	98.01	102.11	88.57	118.81
	Slope (p-value)	-1.35 (0.09)			**-2.43 (p<0.05)***			**-2.88 (0.01)***		
CEREBROVASCULAR										
FEMALE	**2003**	51.03	48.59	53.59	34.34	30.99	38.05	27.40	17.59	38.16
	2004	46.37	44.09	48.78	34.08	30.80	37.71	29.58	21.38	40.41
	2005	46.41	44.17	48.77	29.22	26.23	32.55	18.81	13.96	27.23
	2006	42.45	40.34	44.67	31.38	28.29	34.80	16.62	10.61	25.06
	2007	41.09	39.06	43.22	27.70	24.90	30.82	26.26	19.79	35.09
	2008	41.92	39.90	44.04	28.31	25.48	31.46	23.60	17.13	32.47
	2009	36.42	34.56	38.37	27.23	24.48	30.28	16.02	11.14	23.21
	2010	36.07	34.25	37.99	28.12	25.41	31.12	19.18	13.83	26.72
	2011	32.65	30.95	34.44	29.69	26.91	32.76	14.99	10.40	21.74
	Slope (p-value)	**-2.08 (p<0.5)***			**-0.73 (0.02)***			-1.32 (0.05)		
MALE	**2003**	70.50	67.14	74.01	40.14	35.99	44.73	27.13	18.38	39.29
	2004	69.49	66.22	72.90	38.26	34.31	42.64	28.09	20.50	38.96
	2005	63.99	60.93	67.20	37.60	33.73	41.88	33.73	24.30	45.73
	2006	58.76	55.90	61.76	34.85	31.16	38.94	34.83	26.52	46.44
	2007	62.45	59.55	65.48	32.90	29.39	36.80	23.08	16.47	32.74
	2008	62.10	59.27	65.05	32.01	28.60	35.80	17.97	11.54	27.00
	2009	57.03	54.36	59.81	32.00	28.63	35.73	25.93	18.55	36.44
	2010	52.34	49.84	54.97	29.25	26.08	32.78	23.99	17.17	33.29
	2011	50.77	48.35	53.31	32.01	28.73	35.64	21.75	15.33	30.21

Slope (p-value)		**-2.35 (p<0.05)***			**-1.23 (p<0.05)***			-1.10 (0.12)		
COMMUNICABLE										
FEMALE	**2003**	61.20	58.61	63.91	18.05	15.67	20.79	18.05	15.27	20.79
	2004	56.67	54.27	59.19	21.87	19.26	24.82	21.87	19.06	24.82
	2005	60.63	58.20	63.18	20.93	18.42	23.78	20.93	18.52	23.78
	2006	54.32	52.07	56.68	19.74	17.36	22.46	19.74	17.36	22.46
	2007	57.61	55.37	59.95	20.14	17.78	22.83	20.14	17.83	22.83
	2008	60.80	58.55	63.15	22.35	19.89	25.13	22.35	19.89	25.13
	2009	55.77	53.63	58.00	18.94	16.73	21.44	18.94	16.63	21.44
	2010	59.62	57.44	61.89	18.04	15.87	20.50	18.04	15.87	20.50
	2011	56.83	54.76	58.99	18.27	16.17	20.64	18.27	15.97	20.64
Slope (p-value)		-0.20 (0.57)			-0.20 (0.38)			-0.17 (0.05)		
MALE	**2003**	114.59	110.25	119.07	33.28	29.55	37.44	24.30	15.97	35.69
	2004	103.21	99.19	107.38	30.69	27.16	34.65	23.38	15.57	34.18
	2005	112.46	108.36	116.70	33.89	30.26	37.92	23.23	16.33	33.13
	2006	105.92	102.06	109.93	33.45	29.87	37.42	21.44	14.55	31.23
	2007	118.43	114.45	122.54	29.48	26.21	33.14	15.24	9.78	23.52
	2008	119.60	115.69	123.65	33.72	30.24	37.57	18.64	12.50	27.21
	2009	111.92	108.22	115.74	29.32	26.14	32.87	16.18	10.32	23.97
	2010	113.84	110.19	117.61	34.05	30.66	37.80	24.64	17.52	34.30
	2011	117.54	113.90	121.29	34.15	30.79	37.86	18.90	12.99	27.25
Slope (p-value)		0.94 (0.21)			0.08 (0.78)			-0.58 (0.23)		

*Significant trends (p<0.05) are indicated in bold

Table S2. Year by year mortality age-standardized mortality rates, regression slopes (annual rate of change) and p-values for all cause mortality, cancer, heart disease, cerebrovascular disease, and communicable diseases by sex and Japanese population (Japan, Foreign-Born, and US-born) for the years 2003-2011.

		JAPAN			FOREIGN BORN			US BORN		
ALL CAUSE		**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**
FEMALE	**2003**	428.27	426.87	429.67	378.23	354.32	403.98	333.43	311.88	354.64
	2004	421.76	420.38	423.15	394.92	370.22	421.48	345.80	324.33	367.33
	2005	423.98	422.61	425.36	404.01	379.18	430.70	358.64	337.39	380.78
	2006	411.52	410.18	412.87	397.60	373.27	423.78	349.50	328.30	371.19
	2007	404.82	403.49	406.15	421.44	396.51	448.21	326.74	306.46	347.19
	2008	402.56	401.24	403.87	422.14	397.57	448.52	351.80	330.88	372.83
	2009	388.39	387.10	389.68	435.58	410.66	462.32	360.91	339.38	382.94
	2010	392.71	391.43	393.99	474.60	448.52	502.52	324.85	305.46	344.72
	2011	406.83	405.51	408.15	536.36	508.06	566.52	352.40	331.11	373.80
	Slope (p-value)	**-4.22 (p<0.05)***			**15.99 (p<0.05)**			0.31 (0.36)		
MALE	**2003**	847.69	845.38	850.00	556.58	495.32	624.43	592.63	563.37	621.90
	2004	828.51	826.26	830.77	547.85	486.92	615.42	597.54	571.35	626.73
	2005	836.27	834.04	838.50	627.43	560.55	701.10	613.93	588.15	643.72
	2006	805.57	803.41	807.74	663.32	595.26	738.09	608.71	583.53	637.90
	2007	792.95	790.83	795.08	619.26	553.45	691.81	596.70	569.62	625.80
	2008	786.54	784.45	788.63	590.96	526.95	661.72	600.38	573.30	629.49
	2009	763.39	761.35	765.44	660.87	591.65	736.97	589.55	562.15	617.97
	2010	769.45	767.43	771.48	660.54	592.36	735.52	601.87	572.94	630.83
	2011	772.38	770.37	774.40	599.09	533.90	671.14	600.55	571.50	629.64
	Slope (p-value)	**-10.72 (p<0.05)***			8.38 (0.15)			-0.21 (0.85)		
CANCER										
FEMALE	**2003**	138.91	138.04	139.78	127.12	113.30	142.86	103.72	92.28	117.44
	2004	140.68	139.82	141.56	143.54	128.37	160.66	114.80	102.85	129.01
	2005	137.93	137.08	138.79	156.44	140.68	174.16	119.19	106.74	133.93

	2006	135.81	134.97	136.66	147.85	132.95	164.67	97.35	86.59	110.41
	2007	134.17	133.34	135.02	143.93	129.19	160.60	92.68	81.54	106.19
	2008	133.62	132.79	134.46	151.01	136.14	167.79	96.52	85.88	109.47
	2009	130.78	129.97	131.61	142.71	128.24	159.10	106.51	94.48	120.91
	2010	130.86	130.05	131.68	161.08	145.70	178.37	98.42	87.73	111.42
	2011	130.26	129.44	131.07	184.65	167.83	203.42	105.69	94.33	119.40
	Slope (p-value)	**-1.34 (p<0.05)***			**4.31 (0.02)***				-1.1 (0.25)	
MALE										
	2003	283.04	281.73	284.35	154.55	123.48	192.36	156.97	142.1	172.82
	2004	283.54	282.25	284.84	131.40	103.00	166.59	164.37	150	180.49
	2005	277.57	276.31	278.83	160.14	128.31	198.77	166.48	152	182.96
	2006	271.81	270.58	273.05	206.05	169.63	249.24	153.79	141.3	169.42
	2007	268.98	267.77	270.19	209.54	172.68	253.20	163.84	148	179.81
	2008	265.28	264.10	266.48	177.17	143.58	217.59	163.49	147	179.78
	2009	257.57	256.41	258.73	196.60	159.38	240.99	149.59	135.48	164.83
	2010	256.41	255.27	257.56	221.27	183.25	266.13	158.02	143.23	173.97
	2011	252.18	251.06	253.31	215.63	177.85	260.32	154.91	140.27	170.73
	Slope (p-value)	**-4.19 (p<0.05)***			**9.30 (p<0.05)***				-0.86 (0.28)	
HEART DISEASE										
FEMALE	**2003**	69.50	68.99	70.02	74.86	64.80	86.82	70.04	62.59	79.68
	2004	67.23	66.73	67.73	73.41	63.46	85.26	70.13	62.49	79.97
	2005	68.88	68.39	69.39	70.77	61.04	82.40	64.86	57.51	74.46
	2006	66.26	65.77	66.74	74.53	64.58	86.38	75.78	67.15	86.66
	2007	64.54	64.07	65.02	73.13	63.41	84.75	65.22	58.12	74.56
	2008	63.73	63.27	64.20	76.56	66.46	88.58	76.57	68.74	86.63
	2009	60.53	60.08	60.98	76.25	66.39	88.00	74.05	66.39	83.94
	2010	60.92	60.48	61.36	77.77	67.85	89.59	61.72	54.99	70.73
	2011	60.46	60.03	60.90	86.33	75.50	99.10	67.33	60.62	76.29
	Slope (p-value)	**-1.24 (p<0.05)***			**1.20 (0.02)***				-0.28 (0.70)	
MALE	**2003**	122.91	122.04	123.79	130.85	101.79	166.83	165.93	151.76	182.19

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	2004	118.61	117.76	119.46	155.34	122.31	195.55	163.40	147.76	179.12
	2005	123.12	122.27	123.97	150.81	118.08	190.79	160.66	142.99	176.42
	2006	117.54	116.72	118.37	177.30	142.14	219.59	161.88	146.65	177.19
	2007	113.91	113.12	114.72	133.82	104.06	170.65	147.56	133.49	162.76
	2008	113.83	113.04	114.62	118.14	90.21	153.21	153.48	142.44	168.64
	2009	109.18	108.41	109.95	161.01	128.02	201.10	159.99	144.54	175.35
	2010	109.56	108.81	110.32	144.36	113.32	182.51	153.29	138.36	168.73
	2011	109.15	108.40	109.90	113.44	86.31	147.72	153.67	142.37	168.98
	Slope (p-value)	**-1.90 (p<0.05)***			-2.36 (0.46)			-1.47 (0.05)		
CEREBROVASCULAR										
FEMALE	**2003**	57.56	57.08	58.03	33.22	26.41	42.06	35.40	29.88	43.37
	2004	54.41	53.96	54.88	31.33	24.62	40.12	34.08	28.83	42.27
	2005	52.99	52.54	53.44	28.20	21.91	36.57	35.79	29.99	44.05
	2006	49.08	48.65	49.51	26.31	20.04	34.73	30.97	25.51	38.92
	2007	46.52	46.11	46.94	38.57	31.43	47.71	30.51	25.45	38.04
	2008	44.57	44.16	44.97	29.81	23.50	38.19	27.44	22.80	34.58
	2009	41.25	40.87	41.64	35.27	28.61	43.92	25.12	20.92	31.88
	2010	39.59	39.21	39.96	40.08	32.76	49.41	22.60	18.52	29.28
	2011	38.80	38.43	39.17	36.81	29.72	45.95	29.32	24.27	36.92
	Slope (p-value)	**-2.46 (p<0.05)***			0.97 (0.12)			**-1.39 (p<0.05)***		
MALE	**2003**	96.00	95.24	96.77	60.09	41.21	86.07	41.57	33.27	50.12
	2004	90.18	89.45	90.91	35.22	21.52	56.11	42.22	33.85	50.85
	2005	89.51	88.80	90.23	52.80	34.81	78.14	43.90	37.15	52.93
	2006	83.46	82.78	84.15	27.56	14.52	48.63	40.25	34.03	48.75
	2007	80.07	79.41	80.74	42.30	26.55	65.48	38.61	32.57	46.95
	2008	77.33	76.69	77.97	36.88	21.36	60.36	38.83	32.24	47.79
	2009	72.73	72.12	73.35	47.06	30.15	71.43	35.31	29.52	43.45
	2010	71.48	70.88	72.09	43.93	27.54	67.90	35.07	29.06	43.46
	2011	68.24	67.66	68.83	41.93	26.15	65.24	38.92	32.80	47.39

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Slope (p-value)		**-3.45 (p<0.05)***			-0.81 (0.55)			**-0.84 (0.01)***		
COMMUNICABLE										
FEMALE	**2003**	44.36	43.97	44.76	25.20	19.55	32.88	19.34	15.47	25.78
	2004	42.41	42.03	42.79	20.40	15.34	27.54	18.44	14.14	25.39
	2005	45.16	44.78	45.55	22.99	17.72	30.30	20.16	15.82	27.10
	2006	43.35	42.98	43.73	20.57	15.75	27.44	20.00	15.41	27.59
	2007	41.86	41.50	42.22	21.31	16.22	28.47	17.84	13.38	24.47
	2008	41.71	41.35	42.07	23.68	18.61	30.75	19.86	15.21	27.23
	2009	39.08	38.74	39.43	19.59	14.92	26.32	17.78	13.26	25.07
	2010	39.26	38.92	39.60	27.31	21.16	35.57	18.82	14.02	25.67
	2011	39.61	39.27	39.95	29.68	23.34	38.10	14.31	11.43	20.00
Slope (p-value)		**-0.70 (p<0.05)***			0.58 (0.21)			-0.45 (0.09)		
MALE	**2003**	95.28	94.54	96.03	34.95	20.69	56.69	31.00	25.09	39.29
	2004	92.11	91.40	92.84	33.84	20.19	54.84	30.39	24.89	38.23
	2005	98.07	97.34	98.80	31.54	17.39	53.65	32.90	26.93	41.24
	2006	92.28	91.59	92.98	35.09	21.14	56.41	34.54	28.66	42.75
	2007	90.61	89.94	91.28	39.56	24.26	62.37	26.87	22.23	33.88
	2008	89.74	89.09	90.40	41.26	23.92	66.95	33.19	27.37	41.38
	2009	84.28	83.66	84.91	19.75	9.36	38.20	28.22	23.34	35.49
	2010	85.71	85.09	86.33	33.55	18.80	56.39	29.95	24.86	37.43
	2011	85.56	84.96	86.18	25.95	13.49	46.49	28.27	23.45	35.49
Slope (p-value)		**-1.47 (p<0.05)***			-0.90 (0.32)			-0.38 (0.28)		

*Significant trends (p<0.05) are indicated in bold

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract – page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found – page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported – pages 4-5
Objectives	3	State specific objectives, including any prespecified hypotheses – page 5
Methods		
Study design	4	Present key elements of study design early in the paper- pages 6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection – pages 6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants – pages 6-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – page 8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group – page 8
Bias	9	Describe any efforts to address potential sources of bias – page 8
Study size	10	Explain how the study size was arrived at – page 9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions - pages 6-8
		(*c*) Explain how missing data were addressed –page 6-7
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy – page 8
		(*e*) Describe any sensitivity analyses –N/A

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed – N/A
		(b) Give reasons for non-participation at each stage – N/A
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders – pages 9-10, Table 1
		(b) Indicate number of participants with missing data for each variable of interest –N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) – N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time –N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure –N/A
		Cross-sectional study—Report numbers of outcome events or summary measures – pages 9-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included –pages 10-12, Table 2
		(*b*) Report category boundaries when continuous variables were categorized – page 10, Table 2
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period –page 12, Figure 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses – page 12
Discussion		
Key results	18	Summarise key results with reference to study objectives –page 12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias –page 16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence –pages 13-17
Generalisability	21	Discuss the generalisability (external validity) of the study results –page 6
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based –page 18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

This checklist has been completed and approved by:

Dr. Latha Palaniappan, MD, MS
Date: 4/8/2016

BMJ Open

U.S. national mortality differences between two Asian subgroups, nativity status, and country of origin from 2003-2011: unveiling disparities through disaggregation

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Title: U.S. national mortality differences between two Asian subgroups, nativity status, and country of origin from 2003-2011: unveiling disparities through disaggregation

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ABSTRACT

Background: With immigration and minority populations rapidly growing in the U.S., it is critical to assess how these populations fare after immigration, and in subsequent generations. Our aim is to compare death rates and cause of death across foreign born, U.S. born, and country of origin Chinese and Japanese populations.

Methods: We analyzed all-cause and cause-specific age-standardized mortality rates and trends using 2003-2011 U.S. death record data for Chinese and Japanese decedents aged 25 or older by nativity status and sex, and used the World Health Organization Mortality Database for Hong Kong and Japan decedents in the same years. Characteristics such as age at death, absolute number of deaths by cause, and educational attainment were also reported.

Results: We examined a total of 10,458,849 deaths. All-cause mortality was highest in Hong Kong and Japan, intermediate for foreign-born, and lowest for U.S.-born decedents. Improved mortality outcomes and higher educational attainment among foreign-born were observed compared to developed Asia counterparts. Lower rates in U.S.-born decedents were due to decreased cancer and communicable disease mortality rates in the U.S. Heart disease mortality was either similar or slightly higher among Chinese and Japanese Americans compared to those in developed Asia counterparts.

Conclusion: Mortality advantages in the U.S were largely due to improvements in cancer and communicable disease mortality outcomes. Mortality advantages and higher educational attainments for foreign-born populations compared to developed Asia counterparts may suggest selective migration. Findings add to our limited understanding of the racial and environmental contributions to immigrant health disparities.

STRENGTHS AND LIMITATIONS:

- First study to examine national mortality by disaggregated Asian subgroups and nativity status, in comparison to rates in country of origin using over a decade of data. Lack of country of origin comparisons in previous studies has limited our full understanding of how populations fare after immigration to the U.S.

- U.S. mortality death records may contain errors in the documented cause of death and racial/ethnic misclassification leading to under or over represented cause-specific death rates

- Foreign-born data does not indicate duration of residence, and does not differentiate between naturalized immigrants, permanent residents, nonimmigrants (e.g. temporary workers, students, and visitors), and illegal immigrants.

- Incomplete country comparison groups for the Chinese population (Hong Kong) as available in the WHO mortality database may limit our interpretations. However, this segmented Chinese population better controls for differences in level of economic development and access to medical technologies, etc.

INTRODUCTION

Epidemiologic transitions are well underway in developing countries, and patterns of disease are beginning to reflect those seen in developed countries. Non-communicable diseases such as cardiovascular disease (CVD) and cancers are now the leading causes of death around the world, accounting for 68% (38 million) of all deaths globally in 2012, an increase from 60% (30 million) in 2000.[1] While widely studied in native populations, our understanding of disease patterns in diverse and immigrant populations is limited. Worldwide, immigration rates are increasing at unprecedented rates, with global immigrant population projections estimated to double in size to 405 million by 2050,[2] yet little research explores how nativity status (foreign-born vs. native born) may play a role in health or mortality risk factors. Prior evidence has documented serious health disparities between immigrant populations and host populations, with many immigrants experiencing significantly worse health outcomes and disproportionately suffering from heart attacks, cancer, diabetes, strokes, and HIV/AIDS compared to native populations.[3]

Host and sending countries differ, as do the self-selection of immigrants; poor immigrants fleeing violence and poverty differ from professionals migrating for education and career opportunities. Given the lack of data quantifying immigrant health in national databases (i.e. lack of acculturation proxies, undocumented immigrants, language barriers during data collection, unrepresentative, etc.), studies find inconsistent conclusions regarding health risks in host countries. For example, some studies describe lower CVD risks and mortality among recent immigrants to developed countries compared to long-term immigrants[4-6]; others describe increased risks.[7-9] The “Healthy Migrant Effect”[10] posits that on many measures, new immigrants are healthier than average for the sending country, and may also be healthier than

subsequent generations who share similar ethnic or racial backgrounds in the host country. This selective migration reflects both that migrants are often of higher socioeconomic status (SES) than the average population of the sending country (despite lower socioeconomic positions within the host country), as well as of better health conditional on SES.[11]

However, even healthy immigrants from developing countries have been exposed to a different disease environment in childhood than those born in developed countries, and may be more prone to communicable diseases and infection-induced cancers. These conflicting factors suggest that immigrants may have worse or better health than host populations in the U.S. or other high-income countries, in addition to facing other known risk factors of immigration such as restricted health care access, language barriers, lower relative SES, discrimination, and more. Additionally, data are severely lacking among specific racial/ethnic immigrant groups, such as Asian subgroups.

Asian populations constitute over 60% of the world's population (4.4 out of 7.3 billion people).[12] Asians are the fastest growing racial/ethnic group in the U.S. and are projected to double in size to over 34 million by 2060.[13] Recent data disaggregated by individual subgroups has raised awareness about morbidity and mortality risks that impact certain Asian Americans disproportionately[14-17], but none have explored these differences by nativity status in comparison to sending country. Our study focuses on two specific Asian American subgroups, Chinese and Japanese. Census data from 2011 show that Chinese Americans are nearly five times greater than the Japanese American population (3,520,150 vs. 756,898, respectively).[18] Differences in immigration histories, as described in separate study[19], have resulted in almost twice as many Chinese immigrants than Japanese immigrants in recent decades (70% vs. 39%, respectively) with settlements in different regions throughout the U.S.

Subgroups are also genetically, culturally, and behaviorally diverse, which may affect mortality risks.

The purpose of this study is to 1) examine decedent characteristics and cause of death differences by nativity (foreign-born vs. U.S. born) for Chinese and Japanese Americans to capture heterogeneity between two commonly aggregated racial/ethnic groups, 2) to compare outcomes to country of origin to observe how mortality burden shifts upon immigration to the U.S, and 3) to report mortality trends from 2003-2011. To our knowledge, this is the first study of its kind. These comparisons will add to our understanding of the racial and environmental contributions to immigrant health disparities in support of improved research agendas, clinical guidelines, and health policies.

METHODS

U.S. study population

We examined U.S. national mortality records from the National Center for Health Statistics' (NCHS) Multiple Cause of Death files from years 2003-2011. Decedents represent non-Hispanic Chinese and Japanese populations as identified on the death records by a funeral director using national guidelines. All analyses are confined to individuals aged 25 years or older to account for potential data limitations in accounting for competing risks (i.e. maternal/infant mortality) in cross-country comparisons. All 50 states and the District of Columbia were included in the analysis, thus results are generalizable.

Year of death, age, sex, location of death, nativity status (foreign-born and U.S born), race/ethnicity of the decedent and the underlying cause of death (disease or injury that initiated the events resulting in death) were identified from death certificates. Note that the foreign-born variable only indicates, "born outside of the United States", and does not provide country of birth

details. "Underlying cause of death" was coded by NCHS using the International Classification of Diseases, 10th revision (ICD-10). Year by year population estimates were calculated from the 2000 and 2010 U.S. Census data using linear interpolation for 2003-2009 and extrapolation for 2011. To evaluate the appropriateness of the linear interpolation approach, we used American Community Survey (ACS) data to plot total U.S. population by year in each group of interest and none of these plots appeared to show a consistent departure from linearity. Additionally, to calculate population estimates by nativity status, we used the Public Use Microdata Sample (PUMS) from the 5-year 2005-2009 ACS database to determine proportions of foreign-born populations for each Asian subgroup, age-group, and sex by state and aggregated those numbers to the nation. For ACS, use of 5-year data is required to provide complete coverage, and the 2005-2009 data are the earliest available and also cover the middle 5 years out of 9 included. However, analyses of individual years will be affected by changes in the percentages of foreign-born and U.S.-born. We adjusted the estimates of percent foreign-born using a linear adjustment based on the overall change in foreign-born from the 2000 and 2010 U.S. censuses.

Chinese and Japanese counterparts in developed Asia

To compare Asian-American mortality to that of ethnic counterparts living in developed Asia, we examined decedent-level mortality records from Hong Kong and Japan from the World Health Organization (WHO) Mortality Database from 2003-2011 which can be obtained from their website (http://www.who.int/healthinfo/mortality_data/en/). Although Chinese Americans may come from a range of regions (PRC, Hong Kong, Macao, Taiwan, southeast Asia), we selected Hong Kong as representative of ethnic Chinese living in developed Asia because of Hong Kong's high quality cause-specific mortality data and similarities in potential conditions

shaping health outcomes (affluence, urbanization, healthcare, etc.). Since Hong Kong has among the best survival rates of all China's cities/provinces[20], this comparison helps to isolate the differences associated with lifetime exposure to an earlier phase of the epidemiologic transition among Chinese living in Asia, rather than current living standards. Whole country data for Japan was available and used for comparison to Japanese American decedents. Average annual population estimates by age and sex from the WHO database were used to calculate age-standardized mortality rates.

Statistical Analysis

The following causes of death (ICD-10 codes) were chosen as outcome variables: All Cause, All Cancer (C00-C97), Heart Disease (I00-I09, I13, I20-I51), Cerebrovascular Disease (I60-I69), Communicable diseases, maternal, and nutritional conditions (A00-B99, G00-G04, N70-N73, J00-J06, J10-J18, J20-J22, H65-H66, O00-O99, P00-P96, E00-E02, E50, D50-D53, D64.9, E51-E64), Influenza and pneumonia (J09-J18), Alzheimer's Disease (G30), Accidents (V01-X59, Y85-Y86), and Chronic Lower Respiratory Diseases (J40-J47). The classification scheme used to categorize all 358 causes of deaths was selected to encompass the leading causes of death in both the U.S. and developed Asia, including the primary non-communicable diseases as well as an aggregated communicable disease category.[21] For both males and females in each group of interest, we first calculated raw mortality rates in each age group and then directly standardized these rates with the 2000 WHO Standard Population to calculate age-standardized mortality rates. We then present these results stratified by sex (female and males).[22]

RESULTS

We examined a total of 10,458,849 (352,822 in Hong Kong, 9,959,489 in Japan, and 146,538 in the U.S.) deaths from 2003 to 2011. One of our first objectives was to observe decedent characteristics between U.S. Chinese and Japanese populations, compared to developed Asia counterparts, as shown in Table 1. In general, females constituted about half of each sub-group, with the exception of foreign-born Japanese (78% females). The median age of death was also similar across Chinese subgroups, around 80 years old, whereas Japanese had a seven-year difference in median age of death between U.S.-born and foreign-born decedents (84 years old vs. 77 years old, respectively). Females had higher median ages of death compared to man across all groups. Among both Chinese and Japanese, foreign-born decedents have received more education than the adult populations in developed Asia, as measured by rates of high school completion, and U.S.-born decedents attained either similar (among Japanese) or higher rates of high school completion (Table 1). Among Chinese Americans, "less than secondary (high school) completed" was 21% for U.S.-born vs. 41% for foreign-born, and "secondary completed" was 52% for U.S born vs. 35% for foreign-born. Educational attainment was similar for Japanese-Americans, regardless of nativity; but over 60% of Japanese-American decedents had completed high school, compared to only 38% of the Japan population.

Table 1. Decedent characteristics using death record data for Chinese and Japanese populations in the U.S. and in developed Asia counterparts (Hong Kong and Japan), 2003-2011.

	Chinese			Japanese		
	Hong Kong	**Foreign born**	**U.S. Born**	**Japan**	**Foreign-born**	**U.S. Born**
Characteristics						
Female (%)	44	48	46	46	78	47
Age at death (n (% of total))						
25-44	14,344 (4.1)	2,843 (3.6)	579 (5.6)	244,460 (2.5)	445 (3.0)	600 (1.4)
45-64	58,852 (16.7)	12,211 (15.7)	1,716 (16.7)	1,341,391 (13.5)	2,118 (14.5)	4,174 (9.6)
65-74	65,330 (18.5)	12,324 (15.8)	1,197 (11.6)	1,772,960 (17.8)	3,437 (23.5)	4,373 (10.0)
75-84	115,505 (32.7)	23,306 (29.9)	3,064 (28.8)	3,118,854 (31.3)	6,114 (41.8)	13,941 (31.9)
85+	98,791 (28.0)	27,274 (35.0)	3,740 (36.3)	3,481,824 (35.0)	2,517 (17.2)	20,565 (47.1)
Median age of deaths	78	80	81	80	77	84
Female/Male	82/75	82/78	83/79	84/77	77/71	85/82

Total number of deaths	352,822	77,958	10,296	9,959,489	14,631	43,653
Avg. population size	5,087,389	1,805,385	316,337	95,717,355	260,884	371,188
Absolute numbers of deaths due to						
Cancer	111,090	24,841	2,657	3,012,577	4,913	9,837
Heart Disease	54,964	18,019	2,806	1,631,231	2,791	11,284
Cerebrovascular Diseases	30,958	6,569	805	1,144,770	1,103	3,726
Communicable, maternal, and nutritional conditions	54,162	5,373	571	1,245,295	813	2,565
Influenza and Pneumonia	43,910	3,427	343	990,576	357	1,697
Alzheimer's Disease	102	1,473	242	25,988	430	1,545
Accidents	6,612	2,517	392	363,844	567	1,277
Chronic Lower Respiratory Diseases	18,541	2,866	238	172,038	468	1,226
Education Attainment						
Less than secondary completed	52.4*	41.0	21.0	42.9*	17.0	21.0
Secondary (high school) Completed	29.0*	35.0	52.0	37.9*	66.0	63.0
Tertiary (college) Completed	18.6*	24.0	27.0	19.2*	17.0	16.0

*International education attainment (i.e. Hong Kong and Japan) was obtained from Barro-lee Educational Attainment dataset, based on the population in 2005 (approximate mid-year) for individuals aged 25+; data can be retrieved at: http://barrolee.com/; individual-level educational data not available within W.H.O mortality records.

Consistent with 2010 Census population data[23], a much larger proportion of Chinese American decedents was foreign-born, whereas for Japanese American decedents, a larger proportion was U.S.-born. According to the absolute number of deaths due to a specific cause (Table 1), cancer ranked as the top cause of death for foreign-born and developed Asia decedents in each of the subgroups (when females and males are aggregated), but heart disease ranked as the leading cause for all U.S.-born counterparts. Cerebrovascular disease ranked third for both the U.S.-born and foreign-born Asian American subgroups, but ranked 4th (with communicable diseases ranking as 3rd) for countries of origin.

Next, we sought to observe differences in cause of death for Chinese and Japanese Americans, and compare rates to developed Asia counterparts as shown in Table 2 and Figure 1. All-cause mortality rates were highest in Hong Kong (434 per 100,000 for females, 783 for males) and Japan (408 for females, 799 for males), intermediate for foreign-born Chinese (319

for females, 468 for males) and Japanese-Americans (429 for females, 614 for males), and lowest for U.S.-born Chinese (260 for females, 383 for males) and Japanese (345 for females, 600 for males) (Table 2). Overall death rates are lower in U.S. born decedents compared to countries of origin, and this is largely due to the difference in cancer deaths in the U.S. for both Chinese and Japanese compared to developed Asia counterparts. Heart disease rates were either similar or slightly higher among Chinese and Japanese in the U.S. compared to those in Asia, with a higher mortality burden from heart disease for U.S born decedents. Mortality rates for communicable diseases were much higher in Asia. The Central Illustration (Figure 1) pictorially demonstrates mortality differences among subgroup populations (ethnicity, nativity status, sex) by top causes of death.

Table 2. Age-adjusted mortality rates with 95% confidence intervals by top causes of death for Chinese and Japanese populations in the U.S. and living in Asia (2003-2011). Data based on individuals aged 25+ years.

			Asia	U.S.	
			Hong Kong	Foreign-born	U.S.-born
FEMALE		**Cause of Death**	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**
	Chinese	All cause	434.4 (432.1-436.7)	319.0 (315.7-322.3)	260.3 (252.2-268.6)
		Cancer	143.9 (142.5-145.3)	107.2 (105.2-109.2)	84.1 (79.1-89.3)
		Heart Disease	68.5 (67.6-69.4)	69.4 (67.9-70.9)	57.2 (53.6-60.9)
		Cerebrovascular Diseases	41.1 (40.4-41.8)	29.9 (28.9-30.9)	21.1 (18.9-23.5)
		Communicable, maternal, and nutritional conditions	58.2 (57.4-58.9)	19.8 (19.0-20.6)	13.3 (11.6-15.2)
		Influenza and Pneumonia	46.1 (45.5-46.8)	12.1 (11.5-12.7)	7.7 (6.5-9.2)
		Alzheimer's Disease	0.1 (0.1-0.2)	6.9 (6.5-7.4)	6.1 (5.2-7.4)
		Accidents	6.5 (6.2-6.8)	10.2 (9.6-10.9)	9.1 (7.6-10.8)
		Chronic Lower Respiratory Diseases	12.8 (12.5-13.2)	7.2 (6.7-7.7)	5.1 (4.0-6.4)
			Japan		
	Japanese	All cause	408.4 (408.0-408.9)	429.0 (420.6-437.7)	344.9 (338.4-351.6)
		Cancer	134.7 (134.4-135.0)	150.8 (145.7-156.2)	103.9 (100.0-108.0)
		Heart Disease	64.5 (64.3-64.7)	75.9 (72.5-79-5)	69.5 (67.0-72.3)
		Cerebrovascular Diseases	46.7 (46.5-46.8)	33.3 (30.9-35.8)	30.2 (28.4-32.2)
		Communicable, maternal, and nutritional conditions	41.7 (41.6-41.9)	23.4 (21.5-25.5)	18.5 (17.1-20.2)
		Influenza and Pneumonia	30.4 (30.3-30.5)	9.7 (8.5-11.1)	9.9 (8.9-11.0)
		Alzheimer's Disease	1.1 (1.1-.1.1)	13.8 (12.4-15.4)	9.7 (9.0-10.6)
		Accidents	15.4 (15.3-15.5)	15.8 (14.1-17.8)	10.6 (9.2-12.2)
		Chronic Lower Respiratory Diseases	4.0 (4.0-4.0)	13.1 (11.8-24.6)	6.8 (6.0-7.9)
			Asia	**U.S.**	
MALE			**Hong Kong**	**Foreign-born**	**U.S.-born**
		Cause of Death	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**
	Chinese	All cause	783.0 (779.5-786.5)	468.1 (463.5-472.6)	383.2 (372.6-394.0)
		Cancer	269.7 (267.6-271.7)	160.6 (157.9-163.3)	102.1 (96.6-108.0)

	Heart Disease	111.0 (109.7-112.3)	103.9 (101.7-106.0)	112.8 (107.1-118.8)
	Cerebrovascular Diseases	60.2 (59.2-61.1)	34.1 (32.9-35.4)	26.0 (23.4-29.0)
	Communicable and nutritional conditions	113.4 (112.1-114.6)	32.5 (32.0-33.7)	20.5 (18.2-23.1)
	Influenza and Pneumonia	90.8 (89.7-92.0)	20.0 (19.1-21.0)	11.1 (9.4-13.0)
	Alzheimer's Disease	0.2 (0.1-0.2)	5.3 (4.9-5.8)	5.2 (4.2-6.5)
	Accidents	20.2 (19.6-20.8)	17.7 (16.8-18.7)	16.0 (13.9-18.4)
	Chronic Lower Respiratory Diseases	51.0 (50.1-51.9)	21.4 (20.5-22.4)	9.4 (7.8-11.2)
		Japan		
Japanese	All Cause	799.1 (798.3-799.8)	613.8 (591.5-636.8)	600.2 (591.1-609.5)
	Cancer	268.2 (267.8-268.6)	185.6 (173.6-198.3)	159.1 (154.4-164.0)
	Heart Disease	115.0 (114.8-115.3)	142.9 (132.1-154.4)	157.8 (153.3-162.5)
	Cerebrovascular Diseases	80.2 (80.0-80.4)	43.1 (37.3-49.7)	39.4 (37.3-41.8)
	Communicable and nutritional conditions	90.1 (89.8-90.3)	32.9 (27.7-38.8)	30.6 (28.7-32.7)
	Influenza and Pneumonia	71.1 (70.9-71.3)	21.2 (17.0-26.3)	18.8 (17.4-20.3)
	Alzheimer's Disease	1.3 (1.2-1.3)	9.7 (6.9-13.4)	9.7 (8.8-10.7)
	Accidents	36.4 (36.2-36.6)	33.2 (28.5-38.6)	26.5 (24.2-29.1)
	Chronic Lower Respiratory Diseases	16.0 (15.9-16.1)	15.4 (11.8-19.8)	18.3 (16.9-20.0)

Finally, we examined mortality trend data from 2003-2011 in the U.S, Hong Kong, and Japan for Chinese and Japanese populations, as shown in Figure 2. Notably, Chinese trends indicate that mortality rates steadily decreased in Hong Kong since 2003 (APC for F: -10.5, $p<0.05$; M: -6.0, $p<0.05$). Japanese all-cause rates have decreased in Japan over the study period as well (F: -4.2, $p<0.05$; M: -10.7, $p<0.05$)(Table S2). Mortality rates by year with 95% CIs and annual percent change (APC) estimates with p-values (Table S1, S2) and cause-specific mortality rates (Figure S1, S2) were presented as supplemental data. Cancer, heart disease, and cerebrovascular diseases decreased in Hong Kong for females and males (Figure S1). The same is true for Japan, in addition to communicable diseases (Figure S2). Conversely, cancer mortality increased by 2% for Chinese and 4% for Japanese foreign-born females, and 9% for Japanese foreign-born males (Table S1, S2).

DISCUSSION

Our study aimed to disaggregate national mortality data by Asian American subgroup (Chinese and Japanese), nativity status (foreign-born vs. U.S.-born), sex, and country of origin to

capture cause of death heterogeneity between groups. Incorporating country of origin data also provides a holistic overview of how certain populations may fare upon immigration in the U.S. The study also aimed to report mortality trends to understand where improvements may or may not be occurring for each population. We showed that U.S.-born Asians have better mortality outcomes than foreign-born Asians, an opposite effect to what has been observed among Hispanic/Latinos in the U.S.[24] Furthermore, our study showed better mortality outcomes and higher educational attainment for foreign-born counterparts compared to populations in native countries, suggestive of selective migration. We explored cause-specific mortality to provide insight into where most of these mortality gains were made, largely from improvements in cancer mortality in the U.S.-born group when compared to decedents in countries of origin.

Population level and infrastructural differences that support or undermine health may contribute to observed mortality patterns. For example, the mortality advantage among Asians in the U.S. (foreign-born and U.S.-born) compared to Hong Kong and Japan is likely explained by decreased exposures to communicable diseases in these countries.[25] Selective migration may also help explain the observed attenuation in foreign-born mortality rates and increased education attainment levels compared to developed Asia counterparts. A "healthy" migrant does not exclusively indicate an advantage over U.S.-born and/or majority populations, but rather how they fare in comparison to sending countries as well. Mexican migrants to the U.S. have shown not to be a selected group of their country of origin (i.e. Mexico), unlike migrants from other distant countries such as in Asia.[26]

The mortality advantage for U.S.-born decedents compared to foreign-born counterparts may be largely attributed to inadequate access to health care and health insurance for immigrant populations according to the Migration Policy Institute.[27] Their analyses using Census data

show that immigrants were more than three times as likely to be uninsured (44%) as native-born citizens (13%). According to 2008-2010 ACS data, one study found that certain Asian American subgroups, such as Chinese and Japanese, were on the lower end of the uninsured population, with Japanese at 7% and Chinese at 14%, compared to the national average of 16%.[28]. This same study showed that Asians with larger percentages of native-born populations were less likely to be uninsured.

Our study has also shown that different causes of death were more important for each subgroup. Increased cancer mortality rates in foreign-born groups compared to U.S.-born are likely caused by higher exposure levels to communicable/infectious diseases in countries of origin[25] and lack of access to preventive screenings for early detection due to higher uninsured rates among foreign-born populations.[28]. Liver cancer has shown to be more important for Chinese immigrants, which likely reflects the high rates of chronic Hepatitis B virus in certain Asian countries, such as China and Vietnam.[29] Other studies have demonstrated that stomach cancer mortality rates are higher for foreign-born Japanese, reflecting the influence of rates of Helicobacter pylori infection and traditional dietary intake of pickled and salted foods.[30, 31]

Increased heart disease mortality rates among Japanese men, and an overall greater proportion of heart disease deaths among all U.S.-born subgroups, may be attributed to acculturation and increased CVD risk factors as illustrated by the landmark Ni-Hon-San study.[32, 33] The Honolulu Heart Program (HPP) evaluated CVD among Japanese men living in Honolulu within the Ni-Hon-San cohort and showed that risk factor levels of those men had risen to levels comparable to non-Hispanic whites (NHWs).[34] However, stroke and coronary heart disease had remained lower than for non-Hispanic whites. The children of HHP study participants were also followed, and investigators found that BMI and diabetes prevalence were

substantially higher in children compared to their fathers, however total cholesterol was lower in children.[35] These observations suggest that acculturation such as adopted dietary and lifestyle behaviors similar to majority populations in the U.S. contribute to changes in CVD risk factors (i.e. increased BP and decreased smoking and alcohol intake) and, subsequently, increased heart disease and decreased stroke mortality, respectively, as also shown in our findings.

Previous studies of foreign-born aggregated Asian Americans have shown lower rates of all-cause mortality compared to their U.S.-born counterparts[36], consistent with health outcomes demonstrated among Hispanic/Latino immigrants in the U.S.[37] As we begin to disentangle ambiguities in mortality outcomes by Asian subgroup, we show that such patterns are not equally reflected among all groups. A similar study disaggregating Asian Americans by foreign- and U.S.-born decedents showed that while Asian Indian, Korean, and Vietnamese foreign-born populations had lower all-cause mortality rates and a higher life expectancy than U.S.-born counterparts, the opposite was true for Chinese, Filipino, and Japanese immigrants.[30] More research must be done to investigate the forces that lead to large variations between immigrant groups in the U.S., and how the health of immigrant children may differentiate from their own (i.e. generational differences). One study speculated that health advantages over other ethnicities might accrue with longer histories of settlement in the U.S. like with Japanese and Chinese Americans.[38] Such analyses may provide important clues as to what degree socio-environmental contexts may play over genetic risk factors in immigrant health.

Limitations include the use of the U.S. mortality death records, which may contain errors in the documented cause of death and racial/ethnic misclassification leading to under or over represented cause-specific death rates.[39] We acknowledge that the sample for Japanese

foreign-born men (approx. 3,200 decedents, or 22% of Japanese foreign-born) is small, which may limit our interpretation for direct comparisons with other subgroups. The gender imbalance in Japanese migration to the U.S. has been previously explained by the influx of "war brides" from 1952-1960, whereby Japanese women entered the U.S. as wives and fiancées of American military personnel.[40] Additionally, foreign-born data does not indicate duration of residence, and does not differentiate between naturalized immigrants, permanent residents, nonimmigrants (e.g. temporary workers, students, and visitors), and illegal immigrants, limiting our interpretations.[10] Comparability of the U.S. and international mortality databases may be compromised due to differences in reporting and coding practices by country. To minimize this uncertainty, authors chose to emphasize causes for which we had reason to believe coding was similar (cardiovascular, cancer, communicable disease), and acknowledge that some causes, such as Alzheimer's Disease[41], may vary substantially. Incomplete country comparison groups for the Chinese population (Hong Kong) as available in the WHO mortality database may limit our interpretations. However, this segmented Chinese population better controls for differences in level of economic development and access to medical technologies, etc. Population sizes are estimated rather than known, so the precision of age-standardized mortality rates may be less than expected and the confidence intervals too narrow. Results are not generalizable to other Asian subgroups, and rates in Hong Kong are not generalizable to mainland China.

From a theoretical standpoint, it is important to consider that all-cause mortality rates among foreign-born groups may be underestimated by reverse migration causing "statistical immortality". This arises if immigrants leave the U.S. in old age and die in other countries without dropping appropriately from the U.S. Census denominator. Reverse migration may be highly selective, with sicker immigrants more inclined to return to their country of origin if and

when they cannot work, and for those with chronic (rather than sudden) causes of death. A recent study found selective reverse migration to be true among Mexican migrants in the U.S., with higher probabilities of Mexican migrants in poor health to return home (and lower probabilities of return in improving health).[42] Statistical immortality may differ by Asian subgroup, given possible differences in ease of return migration. For instance, it may be easier for U.S. citizens to return migrate to Japan rather than China, given the more favorable visa and citizenship requirements.[43, 44] There are also more social protection systems for the elderly in Japan[45][46], compared to China[47]. The exact numbers of return migrants from the U.S. to these respective countries is unknown.

Traditionally, mortality analyses are a valid indicator of a population's health status, yet our findings warrant further investigation upon the socioeconomic indicators impacting mortality outcomes, other health risk factors, and health care utilization differences between foreign-born and U.S.-born counterparts. In effort to improve current targeted prevention strategies for racial/ethnic minorities, our data suggest that heart disease risk factor modification is more important for U.S.-born Chinese and Japanese (similar to majority population) than foreign-born counterparts. Cancer screenings may be more important for foreign-born Chinese and Japanese, such as screening for gastric cancer and liver cancer (infection-induced cancers).

A substantial knowledge gap exists on this topic largely because comparing mortality rates across countries is complex given the differences in disease definitions, racial/ethnic classifications, numbers of years for which data are available, and methods of standardization. Accounting for these limitations, our analyses provide an empirical basis for understanding health disparities among two diverse Asian immigrants in the U.S, compared to developed Asia counterparts. The main findings of our study highlight the importance that not only race/ethnicity

plays, but also nativity status, in unveiling mortality disparities for minority populations in the U.S.

FIGURE LEGENDS

Figure 1. Central Illustration: Age-adjusted mortality rates for Chinese and Japanese populations by top causes of death (cancer, heart disease, cerebrovascular disease, and communicable diseases); combined study years (2003-2011).

Figure 2. Year by year all cause age-adjusted mortality rates plotted from 2003-2011 for Chinese and Japanese populations by sex.

Figure S1. Year by year cause-specific age-adjusted mortality rates (cancer, heart disease, cerebrovascular disease, and communicable disease) plotted from 2003-2011 for Chinese populations by sex.

Figure S2. Year by year cause-specific age-adjusted mortality rates (cancer, heart disease, cerebrovascular disease, and communicable disease) plotted from 2003-2011 for Japanese populations by sex.

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CONTRIBUTORSHIP STATEMENT

KGH and KE designed the analytic plan and formulated research questions/hypotheses. KK and DB data cleaned, analyzed the data, and generated figures. KE, MB, MC, LP provided content expertise and critical overview of the various drafts. MC and LP are study co-principal investigators. All authors were involved in interpreting findings and revising the first draft, which was written by KGH. All authors approved the final draft of the manuscript.

COMPETING INTERESTS

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DATA SHARING

No additional data available.

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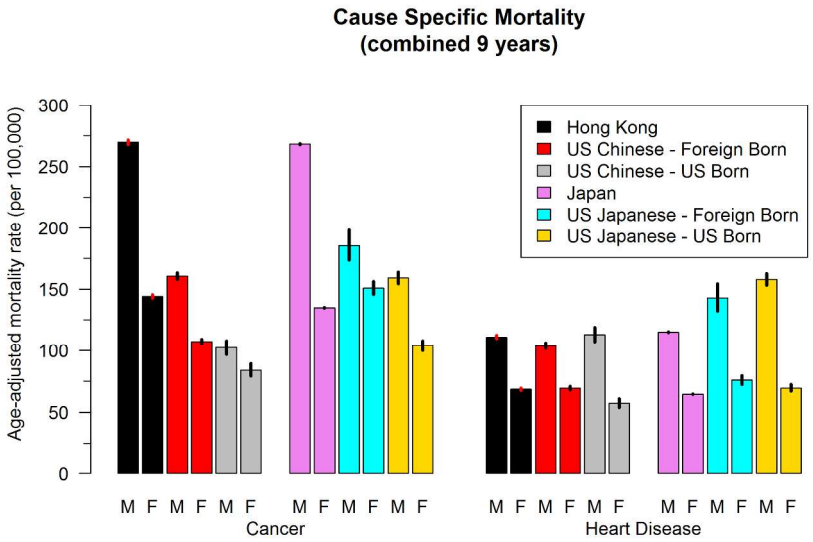

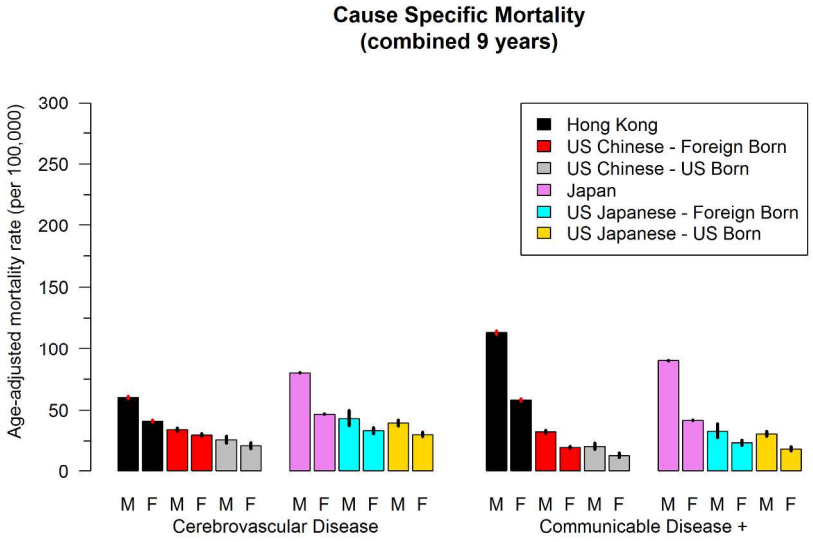

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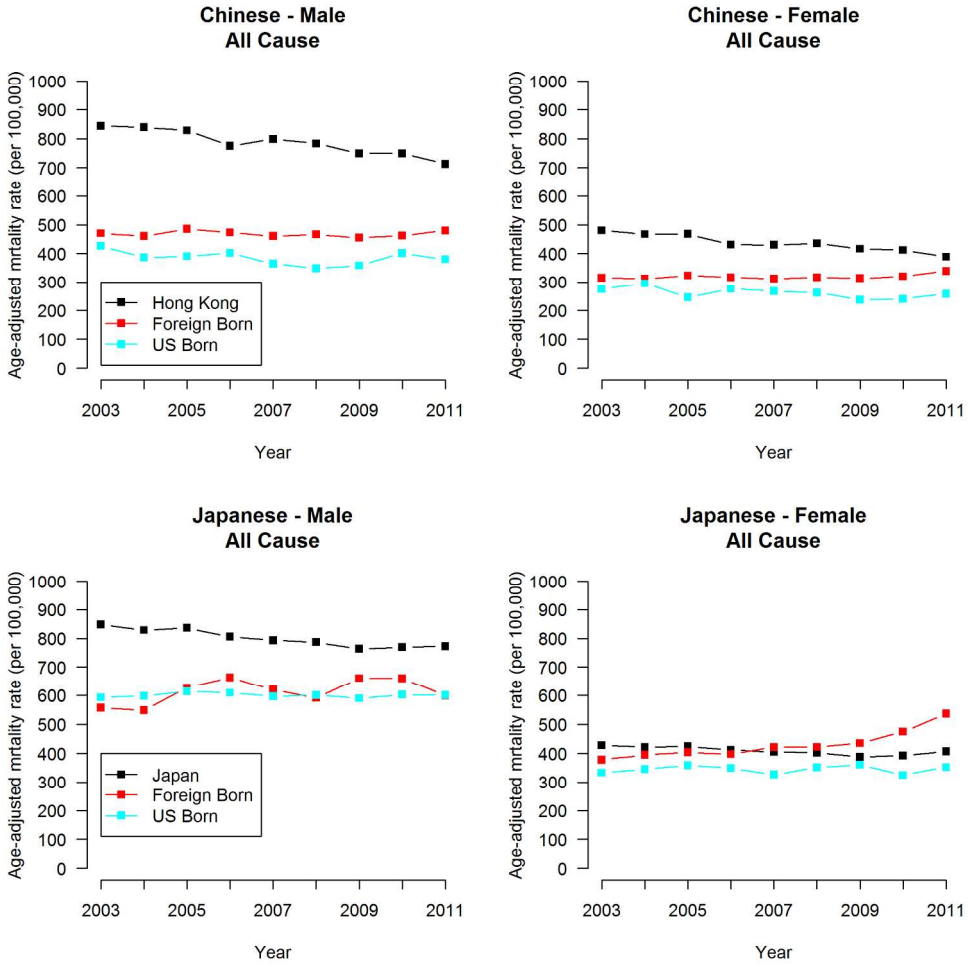

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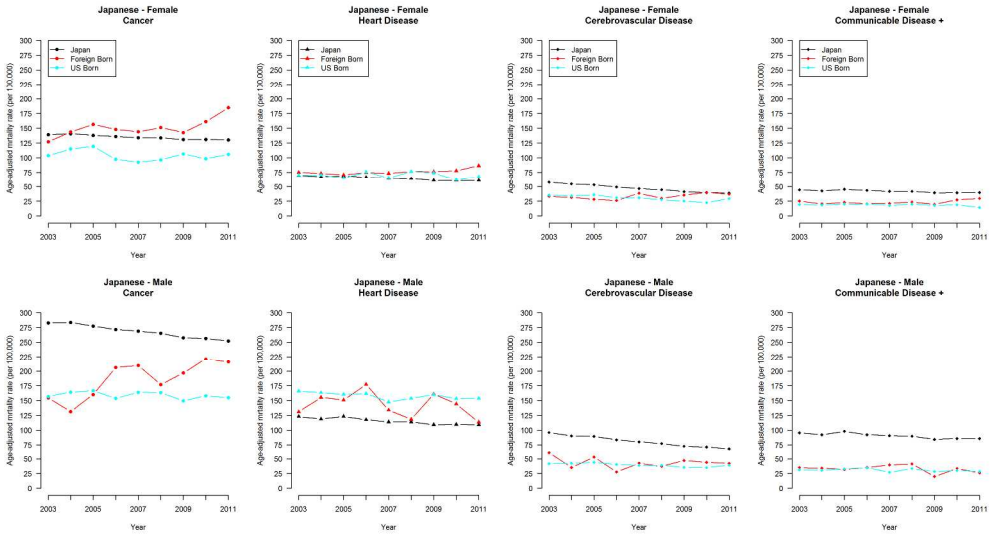

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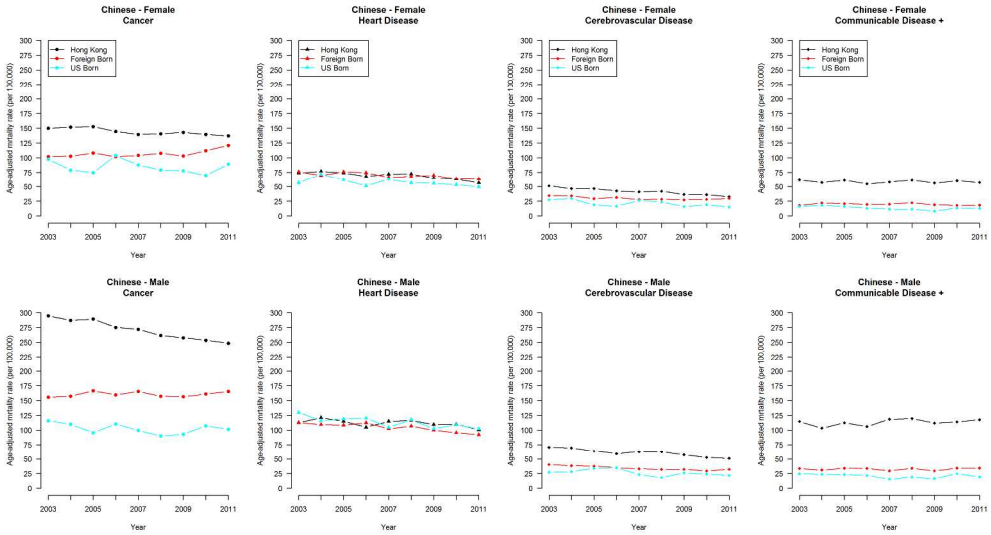

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SUPPLEMENTARY DATA

Table S1. Year by year mortality age-standardized mortality rates, regression slopes (annual rate of change) and p-values for all cause mortality, cancer, heart disease, cerebrovascular disease, and communicable diseases by sex and Chinese population (Hong Kong, Foreign-Born, and US-born) for the years 2003-2011.

		HONG KONG			FOREIGN BORN			US-BORN		
ALL CAUSE		**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**
FEMALE	**2003**	480.32	472.51	488.25	314.94	304.41	325.82	274.85	246.33	304.64
	2004	467.25	459.69	474.92	312.07	301.79	322.69	294.80	265.33	324.82
	2005	467.69	460.27	475.23	323.30	312.98	333.95	245.26	219.33	271.48
	2006	430.90	423.88	438.03	316.58	306.53	326.95	275.06	247.30	302.54
	2007	429.98	423.15	436.92	312.00	302.18	322.12	266.77	240.52	293.24
	2008	435.41	428.67	442.25	316.75	307.05	326.76	261.63	236.42	287.05
	2009	416.55	409.99	423.20	313.34	303.85	323.13	236.55	214.94	260.29
	2010	412.19	405.79	418.69	320.43	310.92	330.23	239.80	218.41	263.25
	2011	388.96	382.86	395.16	338.68	329.03	348.61	257.35	235.18	281.55
	Slope (p-value)	**-10.47 (p<0.05)***			1.67 (0.13)			-4.43 (0.06)		
MALE	**2003**	843.97	832.22	855.86	470.07	455.49	485.09	426.50	390.13	465.93
	2004	838.96	827.45	850.62	460.49	446.32	475.07	386.44	352.71	423.09
	2005	828.35	817.14	839.70	485.26	470.93	500.00	390.37	357.97	425.51
	2006	774.99	764.36	785.76	473.29	459.35	487.63	402.06	369.47	437.31
	2007	798.80	788.25	809.48	460.43	446.92	474.31	364.61	334.21	397.58
	2008	783.53	773.26	793.94	466.40	453.02	480.15	348.49	319.55	379.87
	2009	749.35	739.46	759.36	455.13	442.10	468.53	358.16	328.57	389.97
	2010	749.44	739.73	759.27	462.28	449.30	475.62	401.12	370.84	433.69
	2011	713.06	703.75	722.49	479.69	466.67	493.05	380.00	351.40	410.80
	Slope (p-value)	**-15.69 (p<0.05)***			-0.39 (0.78)			-4.33 (0.19)		
CANCER										
FEMALE	**2003**	149.78	145.17	154.53	101.78	95.59	108.34	97.40	80.67	117.62
	2004	151.75	147.20	156.43	102.58	96.48	109.05	79.07	64.89	96.66

	2005	152.56	148.06	157.20	108.11	101.93	114.63	74.83	61.51	91.18
	2006	144.30	139.99	148.74	101.91	96.00	108.15	103.68	87.83	122.70
	2007	139.47	135.30	143.75	103.95	98.07	110.15	87.72	72.52	105.12
	2008	140.40	136.29	144.63	107.75	101.87	113.96	79.41	66.98	95.16
	2009	142.97	138.86	147.19	102.95	97.30	108.92	77.91	64.88	93.55
	2010	139.42	135.43	143.51	111.78	105.94	117.92	70.11	55.63	84.82
	2011	137.04	133.13	141.04	120.94	114.92	127.25	89.04	74.24	105.19
	Slope (p-value)	**-1.85 (p<0.05)***			**1.66 (0.03)***			-1.11 (0.39)		
MALE										
	2003	294.78	287.90	301.80	155.86	147.42	164.73	115.77	98.30	137.97
	2004	286.97	280.29	293.80	157.22	148.88	165.97	109.84	91.38	131.22
	2005	289.27	282.67	296.00	166.45	158.00	175.31	95.43	79.45	114.64
	2006	275.14	268.82	281.60	159.65	151.51	168.20	110.41	93.32	130.76
	2007	272.20	266.04	278.50	165.31	157.16	173.84	99.39	83.68	118.25
	2008	261.51	255.54	267.60	157.35	149.51	165.56	90.10	75.38	107.18
	2009	257.82	252.00	263.77	156.29	148.59	164.34	92.85	77.69	110.35
	2010	253.57	247.90	259.37	161.03	153.32	169.09	107.18	91.33	125.46
	2011	248.34	242.79	254.01	165.24	157.52	173.31	101.46	86.71	118.85
	Slope (p-value)	**-6.04 (p<0.05)***			0.44 (0.46)			-1.51 (0.20)		
HEART DISEASE										
FEMALE	**2003**	73.81	70.90	76.85	76.08	71.14	81.37	56.51	45.80	69.92
	2004	76.94	74.01	79.98	69.61	64.99	74.56	71.68	59.71	86.67
	2005	73.88	71.07	76.80	76.00	71.24	81.09	61.58	50.16	75.58
	2006	68.11	65.46	70.86	74.36	69.73	79.30	51.01	41.44	62.96
	2007	71.75	69.10	74.51	66.35	62.04	70.96	62.46	51.56	75.72
	2008	72.31	69.72	75.00	67.90	63.63	72.46	56.18	46.21	68.39
	2009	64.88	62.43	67.43	69.80	65.55	74.34	55.43	45.84	67.39
	2010	62.93	60.56	65.38	63.66	59.65	67.95	53.11	44.20	64.16
	2011	56.30	54.12	58.58	63.14	59.19	67.35	49.55	40.84	60.73
	Slope (p-value)	**-2.10 (p<0.05)***			**-1.49 (0.04)***			-1.51 (0.08)		

MALE	**2003**	112.71	108.45	117.12	112.42	105.45	119.83	130.00	110.27	152.63
	2004	120.86	116.53	125.33	109.31	102.54	116.49	115.94	97.74	137.16
	2005	114.80	110.67	119.08	108.46	101.81	115.51	119.02	101.36	139.50
	2006	104.81	100.93	108.82	112.28	105.62	119.33	120.30	103.02	140.15
	2007	114.75	110.80	118.83	102.24	96.00	108.85	104.66	88.57	123.29
	2008	116.37	112.47	120.40	106.71	100.42	113.37	117.57	100.75	136.93
	2009	109.40	105.67	113.25	99.64	93.65	106.00	102.40	86.89	120.18
	2010	109.56	105.89	113.36	95.48	89.72	101.60	109.13	93.59	127.04
	2011	100.75	97.30	104.32	92.10	86.53	98.01	102.11	88.57	118.81
	Slope (p-value)	-1.35 (0.09)			**-2.43 (p<0.05)***			**-2.88 (0.01)***		
CEREBROVASCULAR										
FEMALE	**2003**	51.03	48.59	53.59	34.34	30.99	38.05	27.40	17.59	38.16
	2004	46.37	44.09	48.78	34.08	30.80	37.71	29.58	21.38	40.41
	2005	46.41	44.17	48.77	29.22	26.23	32.55	18.81	13.96	27.23
	2006	42.45	40.34	44.67	31.38	28.29	34.80	16.62	10.61	25.06
	2007	41.09	39.06	43.22	27.70	24.90	30.82	26.26	19.79	35.09
	2008	41.92	39.90	44.04	28.31	25.48	31.46	23.60	17.13	32.47
	2009	36.42	34.56	38.37	27.23	24.48	30.28	16.02	11.14	23.21
	2010	36.07	34.25	37.99	28.12	25.41	31.12	19.18	13.83	26.72
	2011	32.65	30.95	34.44	29.69	26.91	32.76	14.99	10.40	21.74
	Slope (p-value)	**-2.08 (p<0.5)***			**-0.73 (0.02)***			-1.32 (0.05)		
MALE	**2003**	70.50	67.14	74.01	40.14	35.99	44.73	27.13	18.38	39.29
	2004	69.49	66.22	72.90	38.26	34.31	42.64	28.09	20.50	38.96
	2005	63.99	60.93	67.20	37.60	33.73	41.88	33.73	24.30	45.73
	2006	58.76	55.90	61.76	34.85	31.16	38.94	34.83	26.52	46.44
	2007	62.45	59.55	65.48	32.90	29.39	36.80	23.08	16.47	32.74
	2008	62.10	59.27	65.05	32.01	28.60	35.80	17.97	11.54	27.00
	2009	57.03	54.36	59.81	32.00	28.63	35.73	25.93	18.55	36.44
	2010	52.34	49.84	54.97	29.25	26.08	32.78	23.99	17.17	33.29
	2011	50.77	48.35	53.31	32.01	28.73	35.64	21.75	15.33	30.21

Slope (p-value)		**-2.35 (p<0.05)***			**-1.23 (p<0.05)***			-1.10 (0.12)		
COMMUNICABLE										
FEMALE	**2003**	61.20	58.61	63.91	18.05	15.67	20.79	18.05	15.27	20.79
	2004	56.67	54.27	59.19	21.87	19.26	24.82	21.87	19.06	24.82
	2005	60.63	58.20	63.18	20.93	18.42	23.78	20.93	18.52	23.78
	2006	54.32	52.07	56.68	19.74	17.36	22.46	19.74	17.36	22.46
	2007	57.61	55.37	59.95	20.14	17.78	22.83	20.14	17.83	22.83
	2008	60.80	58.55	63.15	22.35	19.89	25.13	22.35	19.89	25.13
	2009	55.77	53.63	58.00	18.94	16.73	21.44	18.94	16.63	21.44
	2010	59.62	57.44	61.89	18.04	15.87	20.50	18.04	15.87	20.50
	2011	56.83	54.76	58.99	18.27	16.17	20.64	18.27	15.97	20.64
Slope (p-value)		-0.20 (0.57)			-0.20 (0.38)			-0.17 (0.05)		
MALE	**2003**	114.59	110.25	119.07	33.28	29.55	37.44	24.30	15.97	35.69
	2004	103.21	99.19	107.38	30.69	27.16	34.65	23.38	15.57	34.18
	2005	112.46	108.36	116.70	33.89	30.26	37.92	23.23	16.33	33.13
	2006	105.92	102.06	109.93	33.45	29.87	37.42	21.44	14.55	31.23
	2007	118.43	114.45	122.54	29.48	26.21	33.14	15.24	9.78	23.52
	2008	119.60	115.69	123.65	33.72	30.24	37.57	18.64	12.50	27.21
	2009	111.92	108.22	115.74	29.32	26.14	32.87	16.18	10.32	23.97
	2010	113.84	110.19	117.61	34.05	30.66	37.80	24.64	17.52	34.30
	2011	117.54	113.90	121.29	34.15	30.79	37.86	18.90	12.99	27.25
Slope (p-value)		0.94 (0.21)			0.08 (0.78)			-0.58 (0.23)		

*Significant trends (p<0.05) are indicated in bold

Table S2. Year by year mortality age-standardized mortality rates, regression slopes (annual rate of change) and p-values for all cause mortality, cancer, heart disease, cerebrovascular disease, and communicable diseases by sex and Japanese population (Japan, Foreign-Born, and US-born) for the years 2003-2011.

		JAPAN			FOREIGN BORN			US BORN		
ALL CAUSE		**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**
FEMALE	**2003**	428.27	426.87	429.67	378.23	354.32	403.98	333.43	311.88	354.64
	2004	421.76	420.38	423.15	394.92	370.22	421.48	345.80	324.33	367.33
	2005	423.98	422.61	425.36	404.01	379.18	430.70	358.64	337.39	380.78
	2006	411.52	410.18	412.87	397.60	373.27	423.78	349.50	328.30	371.19
	2007	404.82	403.49	406.15	421.44	396.51	448.21	326.74	306.46	347.19
	2008	402.56	401.24	403.87	422.14	397.57	448.52	351.80	330.88	372.83
	2009	388.39	387.10	389.68	435.58	410.66	462.32	360.91	339.38	382.94
	2010	392.71	391.43	393.99	474.60	448.52	502.52	324.85	305.46	344.72
	2011	406.83	405.51	408.15	536.36	508.06	566.52	352.40	331.11	373.80
	Slope (p-value)	**-4.22 (p<0.05)***			**15.99 (p<0.05)**			0.31 (0.36)		
MALE	**2003**	847.69	845.38	850.00	556.58	495.32	624.43	592.63	563.37	621.90
	2004	828.51	826.26	830.77	547.85	486.92	615.42	597.54	571.35	626.73
	2005	836.27	834.04	838.50	627.43	560.55	701.10	613.93	588.15	643.72
	2006	805.57	803.41	807.74	663.32	595.26	738.09	608.71	583.53	637.90
	2007	792.95	790.83	795.08	619.26	553.45	691.81	596.70	569.62	625.80
	2008	786.54	784.45	788.63	590.96	526.95	661.72	600.38	573.30	629.49
	2009	763.39	761.35	765.44	660.87	591.65	736.97	589.55	562.15	617.97
	2010	769.45	767.43	771.48	660.54	592.36	735.52	601.87	572.94	630.83
	2011	772.38	770.37	774.40	599.09	533.90	671.14	600.55	571.50	629.64
	Slope (p-value)	**-10.72 (p<0.05)***			8.38 (0.15)			-0.21 (0.85)		
CANCER										
FEMALE	**2003**	138.91	138.04	139.78	127.12	113.30	142.86	103.72	92.28	117.44
	2004	140.68	139.82	141.56	143.54	128.37	160.66	114.80	102.85	129.01
	2005	137.93	137.08	138.79	156.44	140.68	174.16	119.19	106.74	133.93

	2006	135.81	134.97	136.66	147.85	132.95	164.67	97.35	86.59	110.41
	2007	134.17	133.34	135.02	143.93	129.19	160.60	92.68	81.54	106.19
	2008	133.62	132.79	134.46	151.01	136.14	167.79	96.52	85.88	109.47
	2009	130.78	129.97	131.61	142.71	128.24	159.10	106.51	94.48	120.91
	2010	130.86	130.05	131.68	161.08	145.70	178.37	98.42	87.73	111.42
	2011	130.26	129.44	131.07	184.65	167.83	203.42	105.69	94.33	119.40
	Slope (p-value)	**-1.34 (p<0.05)***			**4.31 (0.02)***				-1.1 (0.25)	
MALE										
	2003	283.04	281.73	284.35	154.55	123.48	192.36	156.97	142.1	172.82
	2004	283.54	282.25	284.84	131.40	103.00	166.59	164.37	150	180.49
	2005	277.57	276.31	278.83	160.14	128.31	198.77	166.48	152	182.96
	2006	271.81	270.58	273.05	206.05	169.63	249.24	153.79	141.3	169.42
	2007	268.98	267.77	270.19	209.54	172.68	253.20	163.84	148	179.81
	2008	265.28	264.10	266.48	177.17	143.58	217.59	163.49	147	179.78
	2009	257.57	256.41	258.73	196.60	159.38	240.99	149.59	135.48	164.83
	2010	256.41	255.27	257.56	221.27	183.25	266.13	158.02	143.23	173.97
	2011	252.18	251.06	253.31	215.63	177.85	260.32	154.91	140.27	170.73
	Slope (p-value)	**-4.19 (p<0.05)***			**9.30 (p<0.05)***				-0.86 (0.28)	
HEART DISEASE										
FEMALE	**2003**	69.50	68.99	70.02	74.86	64.80	86.82	70.04	62.59	79.68
	2004	67.23	66.73	67.73	73.41	63.46	85.26	70.13	62.49	79.97
	2005	68.88	68.39	69.39	70.77	61.04	82.40	64.86	57.51	74.46
	2006	66.26	65.77	66.74	74.53	64.58	86.38	75.78	67.15	86.66
	2007	64.54	64.07	65.02	73.13	63.41	84.75	65.22	58.12	74.56
	2008	63.73	63.27	64.20	76.56	66.46	88.58	76.57	68.74	86.63
	2009	60.53	60.08	60.98	76.25	66.39	88.00	74.05	66.39	83.94
	2010	60.92	60.48	61.36	77.77	67.85	89.59	61.72	54.99	70.73
	2011	60.46	60.03	60.90	86.33	75.50	99.10	67.33	60.62	76.29
	Slope (p-value)	**-1.24 (p<0.05)***			**1.20 (0.02)***				-0.28 (0.70)	
MALE	**2003**	122.91	122.04	123.79	130.85	101.79	166.83	165.93	151.76	182.19

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	2004	118.61	117.76	119.46	155.34	122.31	195.55	163.40	147.76	179.12
	2005	123.12	122.27	123.97	150.81	118.08	190.79	160.66	142.99	176.42
	2006	117.54	116.72	118.37	177.30	142.14	219.59	161.88	146.65	177.19
	2007	113.91	113.12	114.72	133.82	104.06	170.65	147.56	133.49	162.76
	2008	113.83	113.04	114.62	118.14	90.21	153.21	153.48	142.44	168.64
	2009	109.18	108.41	109.95	161.01	128.02	201.10	159.99	144.54	175.35
	2010	109.56	108.81	110.32	144.36	113.32	182.51	153.29	138.36	168.73
	2011	109.15	108.40	109.90	113.44	86.31	147.72	153.67	142.37	168.98
	Slope (p-value)	**-1.90 (p<0.05)***			-2.36 (0.46)			-1.47 (0.05)		
CEREBROVASCULAR										
FEMALE	**2003**	57.56	57.08	58.03	33.22	26.41	42.06	35.40	29.88	43.37
	2004	54.41	53.96	54.88	31.33	24.62	40.12	34.08	28.83	42.27
	2005	52.99	52.54	53.44	28.20	21.91	36.57	35.79	29.99	44.05
	2006	49.08	48.65	49.51	26.31	20.04	34.73	30.97	25.51	38.92
	2007	46.52	46.11	46.94	38.57	31.43	47.71	30.51	25.45	38.04
	2008	44.57	44.16	44.97	29.81	23.50	38.19	27.44	22.80	34.58
	2009	41.25	40.87	41.64	35.27	28.61	43.92	25.12	20.92	31.88
	2010	39.59	39.21	39.96	40.08	32.76	49.41	22.60	18.52	29.28
	2011	38.80	38.43	39.17	36.81	29.72	45.95	29.32	24.27	36.92
	Slope (p-value)	**-2.46 (p<0.05)***			0.97 (0.12)			**-1.39 (p<0.05)***		
MALE	**2003**	96.00	95.24	96.77	60.09	41.21	86.07	41.57	33.27	50.12
	2004	90.18	89.45	90.91	35.22	21.52	56.11	42.22	33.85	50.85
	2005	89.51	88.80	90.23	52.80	34.81	78.14	43.90	37.15	52.93
	2006	83.46	82.78	84.15	27.56	14.52	48.63	40.25	34.03	48.75
	2007	80.07	79.41	80.74	42.30	26.55	65.48	38.61	32.57	46.95
	2008	77.33	76.69	77.97	36.88	21.36	60.36	38.83	32.24	47.79
	2009	72.73	72.12	73.35	47.06	30.15	71.43	35.31	29.52	43.45
	2010	71.48	70.88	72.09	43.93	27.54	67.90	35.07	29.06	43.46
	2011	68.24	67.66	68.83	41.93	26.15	65.24	38.92	32.80	47.39

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Slope (p-value)		**-3.45 (p<0.05)***			-0.81 (0.55)			**-0.84 (0.01)***		
COMMUNICABLE										
FEMALE	**2003**	44.36	43.97	44.76	25.20	19.55	32.88	19.34	15.47	25.78
	2004	42.41	42.03	42.79	20.40	15.34	27.54	18.44	14.14	25.39
	2005	45.16	44.78	45.55	22.99	17.72	30.30	20.16	15.82	27.10
	2006	43.35	42.98	43.73	20.57	15.75	27.44	20.00	15.41	27.59
	2007	41.86	41.50	42.22	21.31	16.22	28.47	17.84	13.38	24.47
	2008	41.71	41.35	42.07	23.68	18.61	30.75	19.86	15.21	27.23
	2009	39.08	38.74	39.43	19.59	14.92	26.32	17.78	13.26	25.07
	2010	39.26	38.92	39.60	27.31	21.16	35.57	18.82	14.02	25.67
	2011	39.61	39.27	39.95	29.68	23.34	38.10	14.31	11.43	20.00
Slope (p-value)		**-0.70 (p<0.05)***			0.58 (0.21)			-0.45 (0.09)		
MALE	**2003**	95.28	94.54	96.03	34.95	20.69	56.69	31.00	25.09	39.29
	2004	92.11	91.40	92.84	33.84	20.19	54.84	30.39	24.89	38.23
	2005	98.07	97.34	98.80	31.54	17.39	53.65	32.90	26.93	41.24
	2006	92.28	91.59	92.98	35.09	21.14	56.41	34.54	28.66	42.75
	2007	90.61	89.94	91.28	39.56	24.26	62.37	26.87	22.23	33.88
	2008	89.74	89.09	90.40	41.26	23.92	66.95	33.19	27.37	41.38
	2009	84.28	83.66	84.91	19.75	9.36	38.20	28.22	23.34	35.49
	2010	85.71	85.09	86.33	33.55	18.80	56.39	29.95	24.86	37.43
	2011	85.56	84.96	86.18	25.95	13.49	46.49	28.27	23.45	35.49
Slope (p-value)		**-1.47 (p<0.05)***			-0.90 (0.32)			-0.38 (0.28)		

*Significant trends (p<0.05) are indicated in bold

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract – page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found – page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported – pages 4-5
Objectives	3	State specific objectives, including any prespecified hypotheses – page 5
Methods		
Study design	4	Present key elements of study design early in the paper- pages 6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection – pages 6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants – pages 6-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – page 8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group – page 8
Bias	9	Describe any efforts to address potential sources of bias – page 8
Study size	10	Explain how the study size was arrived at – page 9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions - pages 6-8
		(*c*) Explain how missing data were addressed –page 6-7
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy – page 8
		(*e*) Describe any sensitivity analyses –N/A

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed – N/A
		(b) Give reasons for non-participation at each stage – N/A
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders – pages 9-10, Table 1
		(b) Indicate number of participants with missing data for each variable of interest –N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) – N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time –N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure –N/A
		Cross-sectional study—Report numbers of outcome events or summary measures – pages 9-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included –pages 10-12, Table 2
		(*b*) Report category boundaries when continuous variables were categorized – page 10, Table 2
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period –page 12, Figure 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses – page 12
Discussion		
Key results	18	Summarise key results with reference to study objectives –page 12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias –page 16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence –pages 13-17
Generalisability	21	Discuss the generalisability (external validity) of the study results –page 6
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based –page 18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

This checklist has been completed and approved by:

Dr. Latha Palaniappan, MD, MS
Date: 4/8/2016

BMJ Open

Mortality outcomes for Chinese and Japanese immigrants in the U.S. and countries of origin (Hong Kong, Japan): a comparative analysis using national mortality records from 2003-2011

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Title: Mortality outcomes for Chinese and Japanese immigrants in the U.S. and countries of origin (Hong Kong, Japan): a comparative analysis using national mortality records from 2003-2011

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ABSTRACT

Background: With immigration and minority populations rapidly growing in the U.S., it is critical to assess how these populations fare after immigration, and in subsequent generations. Our aim is to compare death rates and cause of death across foreign born, U.S. born, and country of origin Chinese and Japanese populations.

Methods: We analyzed all-cause and cause-specific age-standardized mortality rates and trends using 2003-2011 U.S. death record data for Chinese and Japanese decedents aged 25 or older by nativity status and sex, and used the World Health Organization Mortality Database for Hong Kong and Japan decedents in the same years. Characteristics such as age at death, absolute number of deaths by cause, and educational attainment were also reported.

Results: We examined a total of 10,458,849 deaths. All-cause mortality was highest in Hong Kong and Japan, intermediate for foreign-born, and lowest for U.S.-born decedents. Improved mortality outcomes and higher educational attainment among foreign-born were observed compared to developed Asia counterparts. Lower rates in U.S.-born decedents were due to decreased cancer and communicable disease mortality rates in the U.S. Heart disease mortality was either similar or slightly higher among Chinese and Japanese Americans compared to those in developed Asia counterparts.

Conclusion: Mortality advantages in the U.S were largely due to improvements in cancer and communicable disease mortality outcomes. Mortality advantages and higher educational attainments for foreign-born populations compared to developed Asia counterparts may suggest selective migration. Findings add to our limited understanding of the racial and environmental contributions to immigrant health disparities.

STRENGTHS AND LIMITATIONS:

- First study to examine national mortality by disaggregated Asian subgroups and nativity status, in comparison to rates in country of origin using over a decade of data. Lack of country of origin comparisons in previous studies has limited our full understanding of how populations fare after immigration to the U.S.

- U.S. mortality death records may contain errors in the documented cause of death and racial/ethnic misclassification leading to under or over represented cause-specific death rates

- Foreign-born data does not indicate duration of residence, and does not differentiate between naturalized immigrants, permanent residents, nonimmigrants (e.g. temporary workers, students, and visitors), and illegal immigrants.

- Incomplete country comparison groups for the Chinese population (Hong Kong) as available in the WHO mortality database may limit our interpretations. However, this segmented Chinese population better controls for differences in level of economic development and access to medical technologies, etc.

INTRODUCTION

Epidemiologic transitions are well underway in developing countries, and patterns of disease are beginning to reflect those seen in developed countries. Non-communicable diseases such as cardiovascular disease (CVD) and cancers are now the leading causes of death around the world, accounting for 68% (38 million) of all deaths globally in 2012, an increase from 60% (30 million) in 2000.[1] While widely studied in native populations, our understanding of disease patterns in diverse and immigrant populations is limited. Worldwide, immigration rates are increasing at unprecedented rates, with global immigrant population projections estimated to double in size to 405 million by 2050,[2] yet little research explores how nativity status (foreign-born vs. native born) may play a role in health or mortality risk factors. Prior evidence has documented serious health disparities between immigrant populations and host populations, with many immigrants experiencing significantly worse health outcomes and disproportionately suffering from heart attacks, cancer, diabetes, strokes, and HIV/AIDS compared to native populations.[3]

Host and sending countries differ, as do the self-selection of immigrants; poor immigrants fleeing violence and poverty differ from professionals migrating for education and career opportunities. Given the lack of data quantifying immigrant health in national databases (i.e. lack of acculturation proxies, undocumented immigrants, language barriers during data collection, unrepresentative, etc.), studies find inconsistent conclusions regarding health risks in host countries. For example, some studies describe lower CVD risks and mortality among recent immigrants to developed countries compared to long-term immigrants[4-6]; others describe increased risks.[7-9] The “Healthy Migrant Effect”[10] posits that on many measures, new immigrants are healthier than average for the sending country, and may also be healthier than

subsequent generations who share similar ethnic or racial backgrounds in the host country. This selective migration reflects both that migrants are often of higher socioeconomic status (SES) than the average population of the sending country (despite lower socioeconomic positions within the host country), as well as of better health conditional on SES.[11]

However, even healthy immigrants from developing countries have been exposed to a different disease environment in childhood than those born in developed countries, and may be more prone to communicable diseases and infection-induced cancers. These conflicting factors suggest that immigrants may have worse or better health than host populations in the U.S. or other high-income countries, in addition to facing other known risk factors of immigration such as restricted health care access, language barriers, lower relative SES, discrimination, and more. Additionally, data are severely lacking among specific racial/ethnic immigrant groups, such as Asian subgroups.

Asian populations constitute over 60% of the world's population (4.4 out of 7.3 billion people).[12] Asians are the fastest growing racial/ethnic group in the U.S. and are projected to double in size to over 34 million by 2060.[13] Recent data disaggregated by individual subgroups has raised awareness about morbidity and mortality risks that impact certain Asian Americans disproportionately[14-17], but none have explored these differences by nativity status in comparison to sending country. Our study focuses on two specific Asian American subgroups, Chinese and Japanese. Census data from 2011 show that Chinese Americans are nearly five times greater than the Japanese American population (3,520,150 vs. 756,898, respectively).[18] Differences in immigration histories, as described in separate study[19], have resulted in almost twice as many Chinese immigrants than Japanese immigrants in recent decades (70% vs. 39%, respectively) with settlements in different regions throughout the U.S.

Subgroups are also genetically, culturally, and behaviorally diverse, which may affect mortality risks.

The purpose of this study is to 1) examine decedent characteristics and cause of death differences by nativity (foreign-born vs. U.S. born) for Chinese and Japanese Americans to capture heterogeneity between two commonly aggregated racial/ethnic groups, 2) to compare outcomes to country of origin to observe how mortality burden shifts upon immigration to the U.S, and 3) to report mortality trends from 2003-2011. To our knowledge, this is the first study of its kind. These comparisons will add to our understanding of the racial and environmental contributions to immigrant health disparities in support of improved research agendas, clinical guidelines, and health policies.

METHODS

U.S. study population

We examined U.S. national mortality records from the National Center for Health Statistics' (NCHS) Multiple Cause of Death files from years 2003-2011. Decedents represent non-Hispanic Chinese and Japanese populations as identified on the death records by a funeral director using national guidelines. All analyses are confined to individuals aged 25 years or older to account for potential data limitations in accounting for competing risks (i.e. maternal/infant mortality) in cross-country comparisons. All 50 states and the District of Columbia were included in the analysis, thus results are generalizable.

Year of death, age, sex, location of death, nativity status (foreign-born and U.S born), race/ethnicity of the decedent and the underlying cause of death (disease or injury that initiated the events resulting in death) were identified from death certificates. Note that the foreign-born variable only indicates, "born outside of the United States", and does not provide country of birth

details. "Underlying cause of death" was coded by NCHS using the International Classification of Diseases, 10th revision (ICD-10). Year by year population estimates were calculated from the 2000 and 2010 U.S. Census data using linear interpolation for 2003-2009 and extrapolation for 2011. To evaluate the appropriateness of the linear interpolation approach, we used American Community Survey (ACS) data to plot total U.S. population by year in each group of interest and none of these plots appeared to show a consistent departure from linearity. Additionally, to calculate population estimates by nativity status, we used the Public Use Microdata Sample (PUMS) from the 5-year 2005-2009 ACS database to determine proportions of foreign-born populations for each Asian subgroup, age-group, and sex by state and aggregated those numbers to the nation. For ACS, use of 5-year data is required to provide complete coverage, and the 2005-2009 data are the earliest available and also cover the middle 5 years out of 9 included. However, analyses of individual years will be affected by changes in the percentages of foreign-born and U.S.-born. We adjusted the estimates of percent foreign-born using a linear adjustment based on the overall change in foreign-born from the 2000 and 2010 U.S. censuses.

Chinese and Japanese counterparts in developed Asia

To compare Asian-American mortality to that of ethnic counterparts living in developed Asia, we examined decedent-level mortality records from Hong Kong and Japan from the World Health Organization (WHO) Mortality Database from 2003-2011 which can be obtained from their website (http://www.who.int/healthinfo/mortality_data/en/). Although Chinese Americans may come from a range of regions (PRC, Hong Kong, Macao, Taiwan, southeast Asia), we selected Hong Kong as representative of ethnic Chinese living in developed Asia because of Hong Kong's high quality cause-specific mortality data and similarities in potential conditions

shaping health outcomes (affluence, urbanization, healthcare, etc.). Since Hong Kong has among the best survival rates of all China's cities/provinces[20], this comparison helps to isolate the differences associated with lifetime exposure to an earlier phase of the epidemiologic transition among Chinese living in Asia, rather than current living standards. Whole country data for Japan was available and used for comparison to Japanese American decedents. Average annual population estimates by age and sex from the WHO database were used to calculate age-standardized mortality rates.

Statistical Analysis

The following causes of death (ICD-10 codes) were chosen as outcome variables: All Cause, All Cancer (C00-C97), Heart Disease (I00-I09, I13, I20-I51), Cerebrovascular Disease (I60-I69), Communicable diseases, maternal, and nutritional conditions (A00-B99, G00-G04, N70-N73, J00-J06, J10-J18, J20-J22, H65-H66, O00-O99, P00-P96, E00-E02, E50, D50-D53, D64.9, E51-E64), Influenza and pneumonia (J09-J18), Alzheimer's Disease (G30), Accidents (V01-X59, Y85-Y86), and Chronic Lower Respiratory Diseases (J40-J47). The classification scheme used to categorize all 358 causes of deaths was selected to encompass the leading causes of death in both the U.S. and developed Asia, including the primary non-communicable diseases as well as an aggregated communicable disease category.[21] For both males and females in each group of interest, we first calculated raw mortality rates in each age group and then directly standardized these rates with the 2000 WHO Standard Population to calculate age-standardized mortality rates. We then present these results stratified by sex (female and males).[22]

RESULTS

We examined a total of 10,458,849 (352,822 in Hong Kong, 9,959,489 in Japan, and 146,538 in the U.S.) deaths from 2003 to 2011. One of our first objectives was to observe decedent characteristics between U.S. Chinese and Japanese populations, compared to developed Asia counterparts, as shown in Table 1. In general, females constituted about half of each sub-group, with the exception of foreign-born Japanese (78% females). The median age of death was also similar across Chinese subgroups, around 80 years old, whereas Japanese had a seven-year difference in median age of death between U.S.-born and foreign-born decedents (84 years old vs. 77 years old, respectively). Females had higher median ages of death compared to man across all groups. Among both Chinese and Japanese, foreign-born decedents have received more education than the adult populations in developed Asia, as measured by rates of high school completion, and U.S.-born decedents attained either similar (among Japanese) or higher rates of high school completion (Table 1). Among Chinese Americans, "less than secondary (high school) completed" was 21% for U.S.-born vs. 41% for foreign-born, and "secondary completed" was 52% for U.S born vs. 35% for foreign-born. Educational attainment was similar for Japanese-Americans, regardless of nativity; but over 60% of Japanese-American decedents had completed high school, compared to only 38% of the Japan population.

Table 1. Decedent characteristics using death record data for Chinese and Japanese populations in the U.S. and in developed Asia counterparts (Hong Kong and Japan), 2003-2011.

	Chinese			Japanese		
	Hong Kong	**Foreign born**	**U.S. Born**	**Japan**	**Foreign-born**	**U.S. Born**
Characteristics						
Female (%)	44	48	46	46	78	47
Age at death (n (% of total))						
25-44	14,344 (4.1)	2,843 (3.6)	579 (5.6)	244,460 (2.5)	445 (3.0)	600 (1.4)
45-64	58,852 (16.7)	12,211 (15.7)	1,716 (16.7)	1,341,391 (13.5)	2,118 (14.5)	4,174 (9.6)
65-74	65,330 (18.5)	12,324 (15.8)	1,197 (11.6)	1,772,960 (17.8)	3,437 (23.5)	4,373 (10.0)
75-84	115,505 (32.7)	23,306 (29.9)	3,064 (28.8)	3,118,854 (31.3)	6,114 (41.8)	13,941 (31.9)
85+	98,791 (28.0)	27,274 (35.0)	3,740 (36.3)	3,481,824 (35.0)	2,517 (17.2)	20,565 (47.1)
Median age of deaths	78	80	81	80	77	84
Female/Male	82/75	82/78	83/79	84/77	77/71	85/82

Total number of deaths	352,822	77,958	10,296	9,959,489	14,631	43,653
Avg. population size	5,087,389	1,805,385	316,337	95,717,355	260,884	371,188
Absolute numbers of deaths due to						
Cancer	111,090	24,841	2,657	3,012,577	4,913	9,837
Heart Disease	54,964	18,019	2,806	1,631,231	2,791	11,284
Cerebrovascular Diseases	30,958	6,569	805	1,144,770	1,103	3,726
Communicable, maternal, and nutritional conditions	54,162	5,373	571	1,245,295	813	2,565
Influenza and Pneumonia	43,910	3,427	343	990,576	357	1,697
Alzheimer's Disease	102	1,473	242	25,988	430	1,545
Accidents	6,612	2,517	392	363,844	567	1,277
Chronic Lower Respiratory Diseases	18,541	2,866	238	172,038	468	1,226
Education Attainment						
Less than secondary completed	52.4*	41.0	21.0	42.9*	17.0	21.0
Secondary (high school) Completed	29.0*	35.0	52.0	37.9*	66.0	63.0
Tertiary (college) Completed	18.6*	24.0	27.0	19.2*	17.0	16.0

*International education attainment (i.e. Hong Kong and Japan) was obtained from Barro-lee Educational Attainment dataset, based on the population in 2005 (approximate mid-year) for individuals aged 25+; data can be retrieved at: http://barrolee.com/; individual-level educational data not available within W.H.O mortality records.

Consistent with 2010 Census population data[23], a much larger proportion of Chinese American decedents was foreign-born, whereas for Japanese American decedents, a larger proportion was U.S.-born. According to the absolute number of deaths due to a specific cause (Table 1), cancer ranked as the top cause of death for foreign-born and developed Asia decedents in each of the subgroups (when females and males are aggregated), but heart disease ranked as the leading cause for all U.S.-born counterparts. Cerebrovascular disease ranked third for both the U.S.-born and foreign-born Asian American subgroups, but ranked 4th (with communicable diseases ranking as 3rd) for countries of origin.

Next, we sought to observe differences in cause of death for Chinese and Japanese Americans, and compare rates to developed Asia counterparts as shown in Table 2 and Figure 1. All-cause mortality rates were highest in Hong Kong (434 per 100,000 for females, 783 for males) and Japan (408 for females, 799 for males), intermediate for foreign-born Chinese (319

for females, 468 for males) and Japanese-Americans (429 for females, 614 for males), and lowest for U.S.-born Chinese (260 for females, 383 for males) and Japanese (345 for females, 600 for males) (Table 2). Overall death rates are lower in U.S. born decedents compared to countries of origin, and this is largely due to the difference in cancer deaths in the U.S. for both Chinese and Japanese compared to developed Asia counterparts. Heart disease rates were either similar or slightly higher among Chinese and Japanese in the U.S. compared to those in Asia, with a higher mortality burden from heart disease for U.S born decedents. Mortality rates for communicable diseases were much higher in Asia. The Central Illustration (Figure 1) pictorially demonstrates mortality differences among subgroup populations (ethnicity, nativity status, sex) by top causes of death.

Table 2. Age-adjusted mortality rates with 95% confidence intervals by top causes of death for Chinese and Japanese populations in the U.S. and living in Asia (2003-2011). Data based on individuals aged 25+ years.

			Asia	U.S.	
			Hong Kong	Foreign-born	U.S.-born
FEMALE		**Cause of Death**	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**
	Chinese	All cause	434.4 (432.1-436.7)	319.0 (315.7-322.3)	260.3 (252.2-268.6)
		Cancer	143.9 (142.5-145.3)	107.2 (105.2-109.2)	84.1 (79.1-89.3)
		Heart Disease	68.5 (67.6-69.4)	69.4 (67.9-70.9)	57.2 (53.6-60.9)
		Cerebrovascular Diseases	41.1 (40.4-41.8)	29.9 (28.9-30.9)	21.1 (18.9-23.5)
		Communicable, maternal, and nutritional conditions	58.2 (57.4-58.9)	19.8 (19.0-20.6)	13.3 (11.6-15.2)
		Influenza and Pneumonia	46.1 (45.5-46.8)	12.1 (11.5-12.7)	7.7 (6.5-9.2)
		Alzheimer's Disease	0.1 (0.1-0.2)	6.9 (6.5-7.4)	6.1 (5.2-7.4)
		Accidents	6.5 (6.2-6.8)	10.2 (9.6-10.9)	9.1 (7.6-10.8)
		Chronic Lower Respiratory Diseases	12.8 (12.5-13.2)	7.2 (6.7-7.7)	5.1 (4.0-6.4)
			Japan		
	Japanese	All cause	408.4 (408.0-408.9)	429.0 (420.6-437.7)	344.9 (338.4-351.6)
		Cancer	134.7 (134.4-135.0)	150.8 (145.7-156.2)	103.9 (100.0-108.0)
		Heart Disease	64.5 (64.3-64.7)	75.9 (72.5-79-5)	69.5 (67.0-72.3)
		Cerebrovascular Diseases	46.7 (46.5-46.8)	33.3 (30.9-35.8)	30.2 (28.4-32.2)
		Communicable, maternal, and nutritional conditions	41.7 (41.6-41.9)	23.4 (21.5-25.5)	18.5 (17.1-20.2)
		Influenza and Pneumonia	30.4 (30.3-30.5)	9.7 (8.5-11.1)	9.9 (8.9-11.0)
		Alzheimer's Disease	1.1 (1.1-.1.1)	13.8 (12.4-15.4)	9.7 (9.0-10.6)
		Accidents	15.4 (15.3-15.5)	15.8 (14.1-17.8)	10.6 (9.2-12.2)
		Chronic Lower Respiratory Diseases	4.0 (4.0-4.0)	13.1 (11.8-24.6)	6.8 (6.0-7.9)
			Asia	**U.S.**	
MALE			**Hong Kong**	**Foreign-born**	**U.S.-born**
		Cause of Death	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**
	Chinese	All cause	783.0 (779.5-786.5)	468.1 (463.5-472.6)	383.2 (372.6-394.0)
		Cancer	269.7 (267.6-271.7)	160.6 (157.9-163.3)	102.1 (96.6-108.0)

	Heart Disease	111.0 (109.7-112.3)	103.9 (101.7-106.0)	112.8 (107.1-118.8)
	Cerebrovascular Diseases	60.2 (59.2-61.1)	34.1 (32.9-35.4)	26.0 (23.4-29.0)
	Communicable and nutritional conditions	113.4 (112.1-114.6)	32.5 (32.0-33.7)	20.5 (18.2-23.1)
	Influenza and Pneumonia	90.8 (89.7-92.0)	20.0 (19.1-21.0)	11.1 (9.4-13.0)
	Alzheimer's Disease	0.2 (0.1-0.2)	5.3 (4.9-5.8)	5.2 (4.2-6.5)
	Accidents	20.2 (19.6-20.8)	17.7 (16.8-18.7)	16.0 (13.9-18.4)
	Chronic Lower Respiratory Diseases	51.0 (50.1-51.9)	21.4 (20.5-22.4)	9.4 (7.8-11.2)
		Japan		
Japanese	All Cause	799.1 (798.3-799.8)	613.8 (591.5-636.8)	600.2 (591.1-609.5)
	Cancer	268.2 (267.8-268.6)	185.6 (173.6-198.3)	159.1 (154.4-164.0)
	Heart Disease	115.0 (114.8-115.3)	142.9 (132.1-154.4)	157.8 (153.3-162.5)
	Cerebrovascular Diseases	80.2 (80.0-80.4)	43.1 (37.3-49.7)	39.4 (37.3-41.8)
	Communicable and nutritional conditions	90.1 (89.8-90.3)	32.9 (27.7-38.8)	30.6 (28.7-32.7)
	Influenza and Pneumonia	71.1 (70.9-71.3)	21.2 (17.0-26.3)	18.8 (17.4-20.3)
	Alzheimer's Disease	1.3 (1.2-1.3)	9.7 (6.9-13.4)	9.7 (8.8-10.7)
	Accidents	36.4 (36.2-36.6)	33.2 (28.5-38.6)	26.5 (24.2-29.1)
	Chronic Lower Respiratory Diseases	16.0 (15.9-16.1)	15.4 (11.8-19.8)	18.3 (16.9-20.0)

Finally, we examined mortality trend data from 2003-2011 in the U.S, Hong Kong, and Japan for Chinese and Japanese populations, as shown in Figure 2. Notably, Chinese trends indicate that mortality rates steadily decreased in Hong Kong since 2003 (APC for F: -10.5, $p<0.05$; M: -6.0, $p<0.05$)(Table S1). Japanese all-cause rates have decreased in Japan over the study period as well (F: -4.2, $p<0.05$; M: -10.7, $p<0.05$)(Table S2). Mortality rates by year with 95% CIs and annual percent change (APC) estimates with p-values (Table S1, S2) and cause-specific mortality rates (Figure S1, S2) were presented as supplemental data. Cancer, heart disease, and cerebrovascular diseases decreased in Hong Kong for females and males (Figure S1). The same is true for Japan, in addition to communicable diseases (Figure S2). Conversely, cancer mortality increased by 2% for Chinese and 4% for Japanese foreign-born females, and 9% for Japanese foreign-born males (Table S1, S2).

DISCUSSION

Our study aimed to disaggregate national mortality data by Asian American subgroup (Chinese and Japanese), nativity status (foreign-born vs. U.S.-born), sex, and country of origin

(Hong Kong and Japan) to capture cause of death heterogeneity between groups. Incorporating country of origin data also provides a holistic overview of how certain populations may fare upon immigration in the U.S. The study also aimed to report mortality trends to understand where improvements may or may not be occurring for each population. We showed that U.S.-born Asians have better mortality outcomes than foreign-born Asians, an opposite effect to what has been observed among Hispanic/Latinos in the U.S.[24] Furthermore, our study showed better mortality outcomes and higher educational attainment for foreign-born counterparts compared to populations in native countries, suggestive of selective migration. We explored cause-specific mortality to provide insight into where most of these mortality gains were made, largely from improvements in cancer mortality in the U.S.-born group when compared to decedents in countries of origin.

Population level and infrastructural differences that support or undermine health may contribute to observed mortality patterns. For example, the mortality advantage among Asians in the U.S. (foreign-born and U.S.-born) compared to Hong Kong and Japan is likely explained by decreased exposures to communicable diseases in these countries.[25] Selective migration may also help explain the observed attenuation in foreign-born mortality rates and increased education attainment levels compared to developed Asia counterparts. A "healthy" migrant does not exclusively indicate an advantage over U.S.-born and/or majority populations, but rather how they fare in comparison to sending countries as well. Mexican migrants to the U.S. have shown not to be a selected group of their country of origin (i.e. Mexico), unlike migrants from other distant countries such as in Asia.[26]

The mortality advantage for U.S.-born decedents compared to foreign-born counterparts may be largely attributed to inadequate access to health care and health insurance for immigrant

populations according to the Migration Policy Institute.[27] Their analyses using Census data show that immigrants were more than three times as likely to be uninsured (44%) as native-born citizens (13%). According to 2008-2010 ACS data, one study found that certain Asian American subgroups, such as Chinese and Japanese, were on the lower end of the uninsured population, with Japanese at 7% and Chinese at 14%, compared to the national average of 16%.[28]. This same study showed that Asians with larger percentages of native-born populations were less likely to be uninsured.

Our study has also shown that different causes of death were more important for each subgroup. Increased cancer mortality rates in foreign-born groups compared to U.S.-born are likely caused by higher exposure levels to communicable/infectious diseases in countries of origin[25] and lack of access to preventive screenings for early detection due to higher uninsured rates among foreign-born populations.[28]. Liver cancer has shown to be more important for Chinese immigrants, which likely reflects the high rates of chronic Hepatitis B virus in certain Asian countries, such as China and Vietnam.[29] Other studies have demonstrated that stomach cancer mortality rates are higher for foreign-born Japanese, reflecting the influence of rates of Helicobacter pylori infection and traditional dietary intake of pickled and salted foods.[30, 31]

Increased heart disease mortality rates among Japanese men, and an overall greater proportion of heart disease deaths among all U.S.-born subgroups, may be attributed to acculturation and increased CVD risk factors as illustrated by the landmark Ni-Hon-San study.[32, 33] The Honolulu Heart Program (HPP) evaluated CVD among Japanese men living in Honolulu within the Ni-Hon-San cohort and showed that risk factor levels of those men had risen to levels comparable to non-Hispanic whites (NHWs).[34] However, stroke and coronary heart disease had remained lower than for non-Hispanic whites. The children of HHP study

participants were also followed, and investigators found that BMI and diabetes prevalence were substantially higher in children compared to their fathers, however total cholesterol was lower in children.[35] These observations suggest that acculturation such as adopted dietary and lifestyle behaviors similar to majority populations in the U.S. contribute to changes in CVD risk factors (i.e. increased BP and decreased smoking and alcohol intake) and, subsequently, increased heart disease and decreased stroke mortality, respectively, as also shown in our findings.

Previous studies of foreign-born aggregated Asian Americans have shown lower rates of all-cause mortality compared to their U.S.-born counterparts[36], consistent with health outcomes demonstrated among Hispanic/Latino immigrants in the U.S.[37] As we begin to disentangle ambiguities in mortality outcomes by Asian subgroup, we show that such patterns are not equally reflected among all groups. A similar study disaggregating Asian Americans by foreign- and U.S.-born decedents showed that while Asian Indian, Korean, and Vietnamese foreign-born populations had lower all-cause mortality rates and a higher life expectancy than U.S.-born counterparts, the opposite was true for Chinese, Filipino, and Japanese immigrants.[30] More research must be done to investigate the forces that lead to large variations between immigrant groups in the U.S., and how the health of immigrant children may differentiate from their own (i.e. generational differences). One study speculated that health advantages over other ethnicities might accrue with longer histories of settlement in the U.S. like with Japanese and Chinese Americans.[38] Such analyses may provide important clues as to what degree socio-environmental contexts may play over genetic risk factors in immigrant health.

Limitations include the use of the U.S. mortality death records, which may contain errors in the documented cause of death and racial/ethnic misclassification leading to under or over

represented cause-specific death rates.[39] We acknowledge that the sample for Japanese foreign-born men (approx. 3,200 decedents, or 22% of Japanese foreign-born) is small, which may limit our interpretation for direct comparisons with other subgroups. The gender imbalance in Japanese migration to the U.S. has been previously explained by the influx of "war brides" from 1952-1960, whereby Japanese women entered the U.S. as wives and fiancées of American military personnel.[40] Additionally, foreign-born data does not indicate duration of residence, and does not differentiate between naturalized immigrants, permanent residents, nonimmigrants (e.g. temporary workers, students, and visitors), and illegal immigrants, limiting our interpretations.[10] Comparability of the U.S. and international mortality databases may be compromised due to differences in reporting and coding practices by country. To minimize this uncertainty, authors chose to emphasize causes for which we had reason to believe coding was similar (cardiovascular, cancer, communicable disease), and acknowledge that some causes, such as Alzheimer's Disease[41], may vary substantially. Incomplete country comparison groups for the Chinese population (Hong Kong) as available in the WHO mortality database may limit our interpretations. However, this segmented Chinese population better controls for differences in level of economic development and access to medical technologies, etc. Population sizes are estimated rather than known, so the precision of age-standardized mortality rates may be less than expected and the confidence intervals too narrow. Results are not generalizable to other Asian subgroups, and rates in Hong Kong are not generalizable to mainland China.

From a theoretical standpoint, it is important to consider that all-cause mortality rates among foreign-born groups may be underestimated by reverse migration causing "statistical immortality". This arises if immigrants leave the U.S. in old age and die in other countries without dropping appropriately from the U.S. Census denominator. Reverse migration may be

highly selective, with sicker immigrants more inclined to return to their country of origin if and when they cannot work, and for those with chronic (rather than sudden) causes of death. A recent study found selective reverse migration to be true among Mexican migrants in the U.S., with higher probabilities of Mexican migrants in poor health to return home (and lower probabilities of return in improving health).[42] Statistical immortality may differ by Asian subgroup, given possible differences in ease of return migration. For instance, it may be easier for U.S. citizens to return migrate to Japan rather than China, given the more favorable visa and citizenship requirements.[43, 44] There are also more social protection systems for the elderly in Japan[45][46], compared to China[47]. The exact numbers of return migrants from the U.S. to these respective countries is unknown.

Traditionally, mortality analyses are a valid indicator of a population's health status, yet our findings warrant further investigation upon the socioeconomic indicators impacting mortality outcomes, other health risk factors, and health care utilization differences between foreign-born and U.S.-born counterparts. In effort to improve current targeted prevention strategies for racial/ethnic minorities, our data suggest that heart disease risk factor modification is more important for U.S.-born Chinese and Japanese (similar to majority population) than foreign-born counterparts. Cancer screenings may be more important for foreign-born Chinese and Japanese, such as screening for gastric cancer and liver cancer (infection-induced cancers).

A substantial knowledge gap exists on this topic largely because comparing mortality rates across countries is complex given the differences in disease definitions, racial/ethnic classifications, numbers of years for which data are available, and methods of standardization. Accounting for these limitations, our analyses provide an empirical basis for understanding health disparities among two diverse Asian immigrants in the U.S, compared to developed Asia

counterparts. The main findings of our study highlight the importance that not only race/ethnicity plays, but also nativity status, in unveiling mortality disparities for minority populations in the U.S.

FIGURE LEGENDS

Figure 1. Central Illustration: Age-adjusted mortality rates for Chinese and Japanese populations by top causes of death (cancer, heart disease, cerebrovascular disease, and communicable diseases); combined study years (2003-2011).

Figure 2. Year by year all cause age-adjusted mortality rates plotted from 2003-2011 for Chinese and Japanese populations by sex.

Figure S1. Year by year cause-specific age-adjusted mortality rates (cancer, heart disease, cerebrovascular disease, and communicable disease) plotted from 2003-2011 for Chinese populations by sex.

Figure S2. Year by year cause-specific age-adjusted mortality rates (cancer, heart disease, cerebrovascular disease, and communicable disease) plotted from 2003-2011 for Japanese populations by sex.

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CONTRIBUTORSHIP STATEMENT

KGH and KE designed the analytic plan and formulated research questions/hypotheses. KK and DB data cleaned, analyzed the data, and generated figures. KE, MB, MC, LP provided content expertise and critical overview of the various drafts. MC and LP are study co-principal investigators. All authors were involved in interpreting findings and revising the first draft, which was written by KGH. All authors approved the final draft of the manuscript.

COMPETING INTERESTS

No financial disclosures or competing interests to disclose.

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DATA SHARING

All data underlying the authors' findings in this study are freely available in public repositories, regulated by the National Center for Health Statistics (NCHS) and the World Health Organization. The authors have obtained individual county-level characteristic data from NCHS for the analyses, thus its public use is restricted. If interested in acquiring these data, please visit the following link for more information: http://www.cdc.gov/nchs/data_access/data_linkage/mortality/data_files_data_dictionaries.htm

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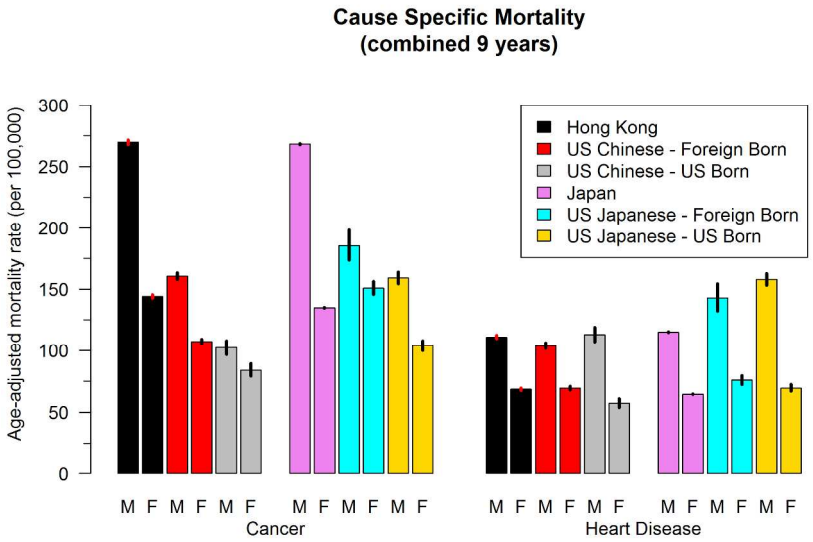

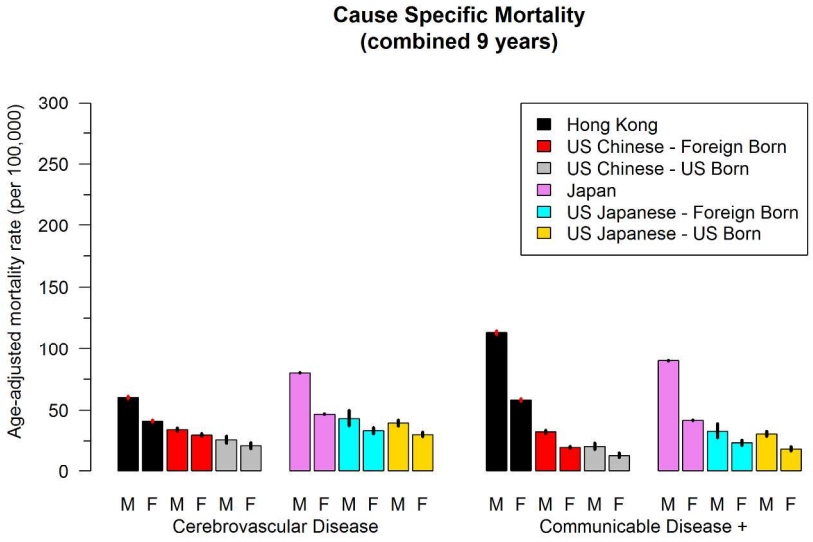

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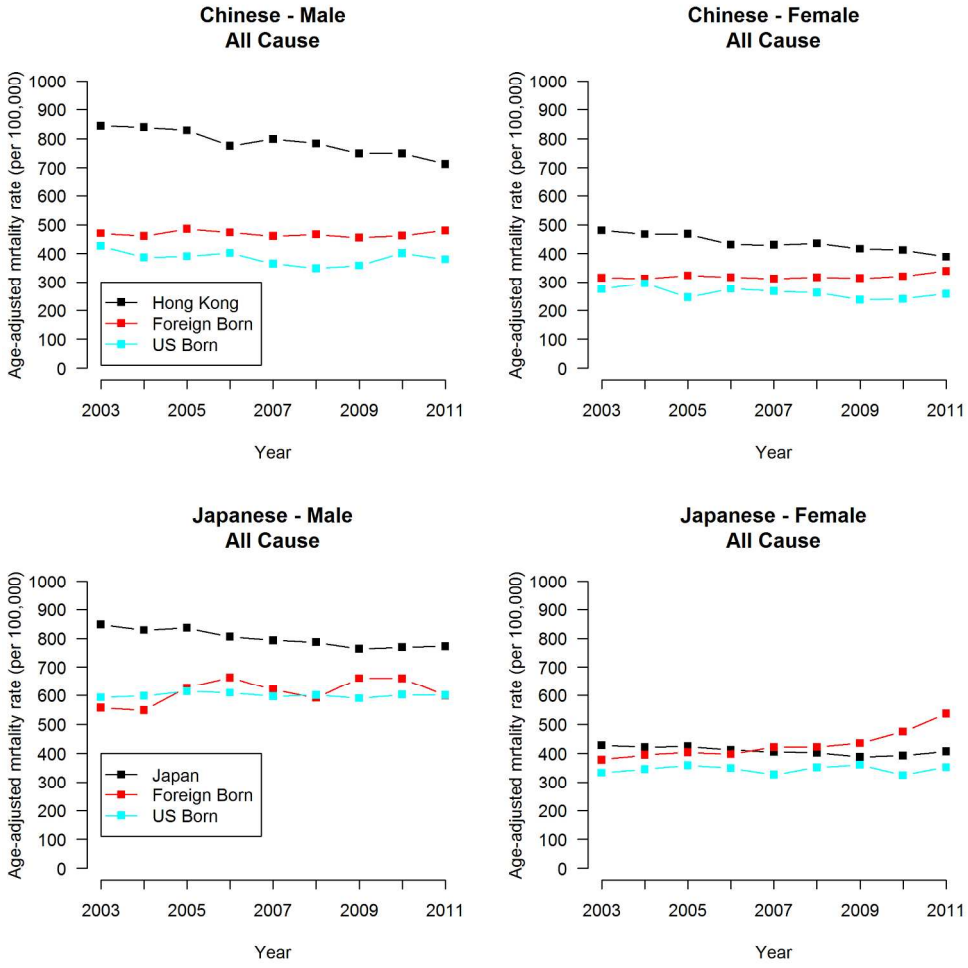

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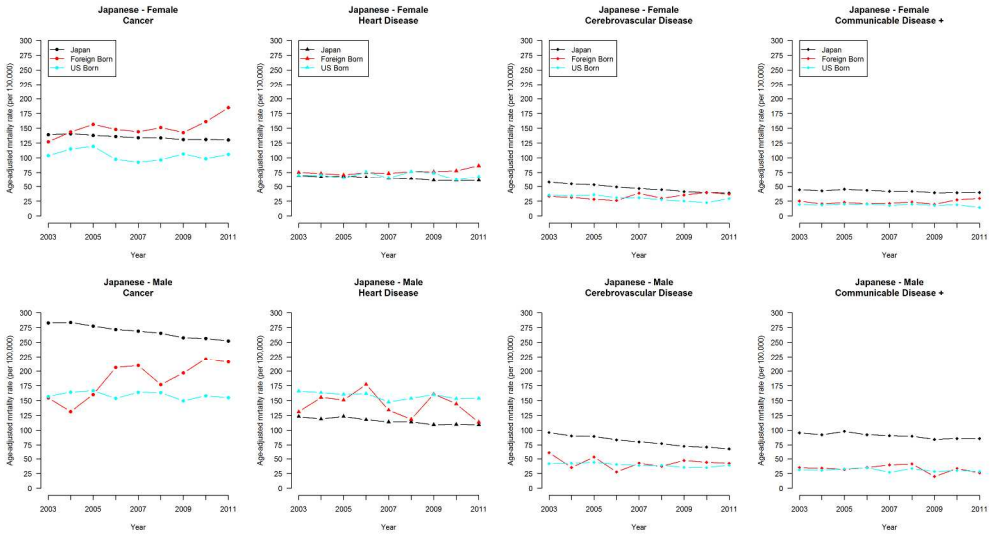

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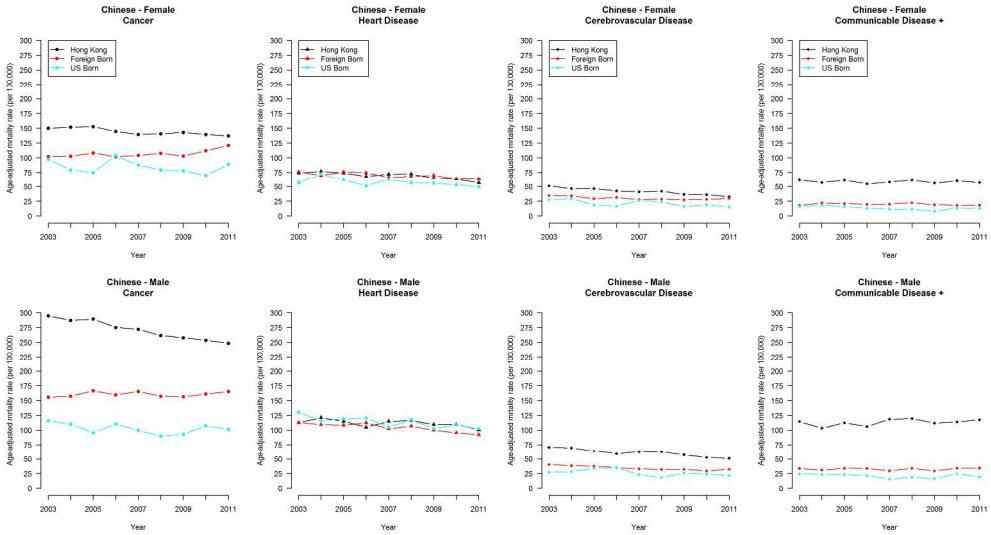

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SUPPLEMENTARY DATA

Table S1. Year by year mortality age-standardized mortality rates, regression slopes (annual rate of change) and p-values for all cause mortality, cancer, heart disease, cerebrovascular disease, and communicable diseases by sex and Chinese population (Hong Kong, Foreign-Born, and US-born) for the years 2003-2011.

		HONG KONG			FOREIGN BORN			US-BORN		
ALL CAUSE		**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**
FEMALE	**2003**	480.32	472.51	488.25	314.94	304.41	325.82	274.85	246.33	304.64
	2004	467.25	459.69	474.92	312.07	301.79	322.69	294.80	265.33	324.82
	2005	467.69	460.27	475.23	323.30	312.98	333.95	245.26	219.33	271.48
	2006	430.90	423.88	438.03	316.58	306.53	326.95	275.06	247.30	302.54
	2007	429.98	423.15	436.92	312.00	302.18	322.12	266.77	240.52	293.24
	2008	435.41	428.67	442.25	316.75	307.05	326.76	261.63	236.42	287.05
	2009	416.55	409.99	423.20	313.34	303.85	323.13	236.55	214.94	260.29
	2010	412.19	405.79	418.69	320.43	310.92	330.23	239.80	218.41	263.25
	2011	388.96	382.86	395.16	338.68	329.03	348.61	257.35	235.18	281.55
	Slope (p-value)	**-10.47 (p<0.05)***			1.67 (0.13)			-4.43 (0.06)		
MALE	**2003**	843.97	832.22	855.86	470.07	455.49	485.09	426.50	390.13	465.93
	2004	838.96	827.45	850.62	460.49	446.32	475.07	386.44	352.71	423.09
	2005	828.35	817.14	839.70	485.26	470.93	500.00	390.37	357.97	425.51
	2006	774.99	764.36	785.76	473.29	459.35	487.63	402.06	369.47	437.31
	2007	798.80	788.25	809.48	460.43	446.92	474.31	364.61	334.21	397.58
	2008	783.53	773.26	793.94	466.40	453.02	480.15	348.49	319.55	379.87
	2009	749.35	739.46	759.36	455.13	442.10	468.53	358.16	328.57	389.97
	2010	749.44	739.73	759.27	462.28	449.30	475.62	401.12	370.84	433.69
	2011	713.06	703.75	722.49	479.69	466.67	493.05	380.00	351.40	410.80
	Slope (p-value)	**-15.69 (p<0.05)***			-0.39 (0.78)			-4.33 (0.19)		
CANCER										
FEMALE	**2003**	149.78	145.17	154.53	101.78	95.59	108.34	97.40	80.67	117.62
	2004	151.75	147.20	156.43	102.58	96.48	109.05	79.07	64.89	96.66

	2005	152.56	148.06	157.20	108.11	101.93	114.63	74.83	61.51	91.18
	2006	144.30	139.99	148.74	101.91	96.00	108.15	103.68	87.83	122.70
	2007	139.47	135.30	143.75	103.95	98.07	110.15	87.72	72.52	105.12
	2008	140.40	136.29	144.63	107.75	101.87	113.96	79.41	66.98	95.16
	2009	142.97	138.86	147.19	102.95	97.30	108.92	77.91	64.88	93.55
	2010	139.42	135.43	143.51	111.78	105.94	117.92	70.11	55.63	84.82
	2011	137.04	133.13	141.04	120.94	114.92	127.25	89.04	74.24	105.19
	Slope (p-value)	**-1.85 (p<0.05)***			**1.66 (0.03)***			-1.11 (0.39)		
MALE										
	2003	294.78	287.90	301.80	155.86	147.42	164.73	115.77	98.30	137.97
	2004	286.97	280.29	293.80	157.22	148.88	165.97	109.84	91.38	131.22
	2005	289.27	282.67	296.00	166.45	158.00	175.31	95.43	79.45	114.64
	2006	275.14	268.82	281.60	159.65	151.51	168.20	110.41	93.32	130.76
	2007	272.20	266.04	278.50	165.31	157.16	173.84	99.39	83.68	118.25
	2008	261.51	255.54	267.60	157.35	149.51	165.56	90.10	75.38	107.18
	2009	257.82	252.00	263.77	156.29	148.59	164.34	92.85	77.69	110.35
	2010	253.57	247.90	259.37	161.03	153.32	169.09	107.18	91.33	125.46
	2011	248.34	242.79	254.01	165.24	157.52	173.31	101.46	86.71	118.85
	Slope (p-value)	**-6.04 (p<0.05)***			0.44 (0.46)			-1.51 (0.20)		
HEART DISEASE										
FEMALE	**2003**	73.81	70.90	76.85	76.08	71.14	81.37	56.51	45.80	69.92
	2004	76.94	74.01	79.98	69.61	64.99	74.56	71.68	59.71	86.67
	2005	73.88	71.07	76.80	76.00	71.24	81.09	61.58	50.16	75.58
	2006	68.11	65.46	70.86	74.36	69.73	79.30	51.01	41.44	62.96
	2007	71.75	69.10	74.51	66.35	62.04	70.96	62.46	51.56	75.72
	2008	72.31	69.72	75.00	67.90	63.63	72.46	56.18	46.21	68.39
	2009	64.88	62.43	67.43	69.80	65.55	74.34	55.43	45.84	67.39
	2010	62.93	60.56	65.38	63.66	59.65	67.95	53.11	44.20	64.16
	2011	56.30	54.12	58.58	63.14	59.19	67.35	49.55	40.84	60.73
	Slope (p-value)	**-2.10 (p<0.05)***			**-1.49 (0.04)***			-1.51 (0.08)		

MALE	**2003**	112.71	108.45	117.12	112.42	105.45	119.83	130.00	110.27	152.63
	2004	120.86	116.53	125.33	109.31	102.54	116.49	115.94	97.74	137.16
	2005	114.80	110.67	119.08	108.46	101.81	115.51	119.02	101.36	139.50
	2006	104.81	100.93	108.82	112.28	105.62	119.33	120.30	103.02	140.15
	2007	114.75	110.80	118.83	102.24	96.00	108.85	104.66	88.57	123.29
	2008	116.37	112.47	120.40	106.71	100.42	113.37	117.57	100.75	136.93
	2009	109.40	105.67	113.25	99.64	93.65	106.00	102.40	86.89	120.18
	2010	109.56	105.89	113.36	95.48	89.72	101.60	109.13	93.59	127.04
	2011	100.75	97.30	104.32	92.10	86.53	98.01	102.11	88.57	118.81
	Slope (p-value)	-1.35 (0.09)			**-2.43 (p<0.05)***			**-2.88 (0.01)***		
CEREBROVASCULAR										
FEMALE	**2003**	51.03	48.59	53.59	34.34	30.99	38.05	27.40	17.59	38.16
	2004	46.37	44.09	48.78	34.08	30.80	37.71	29.58	21.38	40.41
	2005	46.41	44.17	48.77	29.22	26.23	32.55	18.81	13.96	27.23
	2006	42.45	40.34	44.67	31.38	28.29	34.80	16.62	10.61	25.06
	2007	41.09	39.06	43.22	27.70	24.90	30.82	26.26	19.79	35.09
	2008	41.92	39.90	44.04	28.31	25.48	31.46	23.60	17.13	32.47
	2009	36.42	34.56	38.37	27.23	24.48	30.28	16.02	11.14	23.21
	2010	36.07	34.25	37.99	28.12	25.41	31.12	19.18	13.83	26.72
	2011	32.65	30.95	34.44	29.69	26.91	32.76	14.99	10.40	21.74
	Slope (p-value)	**-2.08 (p<0.5)***			**-0.73 (0.02)***			-1.32 (0.05)		
MALE	**2003**	70.50	67.14	74.01	40.14	35.99	44.73	27.13	18.38	39.29
	2004	69.49	66.22	72.90	38.26	34.31	42.64	28.09	20.50	38.96
	2005	63.99	60.93	67.20	37.60	33.73	41.88	33.73	24.30	45.73
	2006	58.76	55.90	61.76	34.85	31.16	38.94	34.83	26.52	46.44
	2007	62.45	59.55	65.48	32.90	29.39	36.80	23.08	16.47	32.74
	2008	62.10	59.27	65.05	32.01	28.60	35.80	17.97	11.54	27.00
	2009	57.03	54.36	59.81	32.00	28.63	35.73	25.93	18.55	36.44
	2010	52.34	49.84	54.97	29.25	26.08	32.78	23.99	17.17	33.29
	2011	50.77	48.35	53.31	32.01	28.73	35.64	21.75	15.33	30.21

Slope (p-value)		**-2.35 (p<0.05)***			**-1.23 (p<0.05)***			-1.10 (0.12)		
COMMUNICABLE										
FEMALE	**2003**	61.20	58.61	63.91	18.05	15.67	20.79	18.05	15.27	20.79
	2004	56.67	54.27	59.19	21.87	19.26	24.82	21.87	19.06	24.82
	2005	60.63	58.20	63.18	20.93	18.42	23.78	20.93	18.52	23.78
	2006	54.32	52.07	56.68	19.74	17.36	22.46	19.74	17.36	22.46
	2007	57.61	55.37	59.95	20.14	17.78	22.83	20.14	17.83	22.83
	2008	60.80	58.55	63.15	22.35	19.89	25.13	22.35	19.89	25.13
	2009	55.77	53.63	58.00	18.94	16.73	21.44	18.94	16.63	21.44
	2010	59.62	57.44	61.89	18.04	15.87	20.50	18.04	15.87	20.50
	2011	56.83	54.76	58.99	18.27	16.17	20.64	18.27	15.97	20.64
Slope (p-value)		-0.20 (0.57)			-0.20 (0.38)			-0.17 (0.05)		
MALE	**2003**	114.59	110.25	119.07	33.28	29.55	37.44	24.30	15.97	35.69
	2004	103.21	99.19	107.38	30.69	27.16	34.65	23.38	15.57	34.18
	2005	112.46	108.36	116.70	33.89	30.26	37.92	23.23	16.33	33.13
	2006	105.92	102.06	109.93	33.45	29.87	37.42	21.44	14.55	31.23
	2007	118.43	114.45	122.54	29.48	26.21	33.14	15.24	9.78	23.52
	2008	119.60	115.69	123.65	33.72	30.24	37.57	18.64	12.50	27.21
	2009	111.92	108.22	115.74	29.32	26.14	32.87	16.18	10.32	23.97
	2010	113.84	110.19	117.61	34.05	30.66	37.80	24.64	17.52	34.30
	2011	117.54	113.90	121.29	34.15	30.79	37.86	18.90	12.99	27.25
Slope (p-value)		0.94 (0.21)			0.08 (0.78)			-0.58 (0.23)		

*Significant trends (p<0.05) are indicated in bold

Table S2. Year by year mortality age-standardized mortality rates, regression slopes (annual rate of change) and p-values for all cause mortality, cancer, heart disease, cerebrovascular disease, and communicable diseases by sex and Japanese population (Japan, Foreign-Born, and US-born) for the years 2003-2011.

		JAPAN			FOREIGN BORN			US BORN		
ALL CAUSE		**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**	**AR**	**LCI**	**UCI**
FEMALE	**2003**	428.27	426.87	429.67	378.23	354.32	403.98	333.43	311.88	354.64
	2004	421.76	420.38	423.15	394.92	370.22	421.48	345.80	324.33	367.33
	2005	423.98	422.61	425.36	404.01	379.18	430.70	358.64	337.39	380.78
	2006	411.52	410.18	412.87	397.60	373.27	423.78	349.50	328.30	371.19
	2007	404.82	403.49	406.15	421.44	396.51	448.21	326.74	306.46	347.19
	2008	402.56	401.24	403.87	422.14	397.57	448.52	351.80	330.88	372.83
	2009	388.39	387.10	389.68	435.58	410.66	462.32	360.91	339.38	382.94
	2010	392.71	391.43	393.99	474.60	448.52	502.52	324.85	305.46	344.72
	2011	406.83	405.51	408.15	536.36	508.06	566.52	352.40	331.11	373.80
	Slope (p-value)	**-4.22 (p<0.05)***			**15.99 (p<0.05)**			0.31 (0.36)		
MALE	**2003**	847.69	845.38	850.00	556.58	495.32	624.43	592.63	563.37	621.90
	2004	828.51	826.26	830.77	547.85	486.92	615.42	597.54	571.35	626.73
	2005	836.27	834.04	838.50	627.43	560.55	701.10	613.93	588.15	643.72
	2006	805.57	803.41	807.74	663.32	595.26	738.09	608.71	583.53	637.90
	2007	792.95	790.83	795.08	619.26	553.45	691.81	596.70	569.62	625.80
	2008	786.54	784.45	788.63	590.96	526.95	661.72	600.38	573.30	629.49
	2009	763.39	761.35	765.44	660.87	591.65	736.97	589.55	562.15	617.97
	2010	769.45	767.43	771.48	660.54	592.36	735.52	601.87	572.94	630.83
	2011	772.38	770.37	774.40	599.09	533.90	671.14	600.55	571.50	629.64
	Slope (p-value)	**-10.72 (p<0.05)***			8.38 (0.15)			-0.21 (0.85)		
CANCER										
FEMALE	**2003**	138.91	138.04	139.78	127.12	113.30	142.86	103.72	92.28	117.44
	2004	140.68	139.82	141.56	143.54	128.37	160.66	114.80	102.85	129.01
	2005	137.93	137.08	138.79	156.44	140.68	174.16	119.19	106.74	133.93

	2006	135.81	134.97	136.66	147.85	132.95	164.67	97.35	86.59	110.41
	2007	134.17	133.34	135.02	143.93	129.19	160.60	92.68	81.54	106.19
	2008	133.62	132.79	134.46	151.01	136.14	167.79	96.52	85.88	109.47
	2009	130.78	129.97	131.61	142.71	128.24	159.10	106.51	94.48	120.91
	2010	130.86	130.05	131.68	161.08	145.70	178.37	98.42	87.73	111.42
	2011	130.26	129.44	131.07	184.65	167.83	203.42	105.69	94.33	119.40
	Slope (p-value)	**-1.34 (p<0.05)***			**4.31 (0.02)***				-1.1 (0.25)	
MALE										
	2003	283.04	281.73	284.35	154.55	123.48	192.36	156.97	142.1	172.82
	2004	283.54	282.25	284.84	131.40	103.00	166.59	164.37	150	180.49
	2005	277.57	276.31	278.83	160.14	128.31	198.77	166.48	152	182.96
	2006	271.81	270.58	273.05	206.05	169.63	249.24	153.79	141.3	169.42
	2007	268.98	267.77	270.19	209.54	172.68	253.20	163.84	148	179.81
	2008	265.28	264.10	266.48	177.17	143.58	217.59	163.49	147	179.78
	2009	257.57	256.41	258.73	196.60	159.38	240.99	149.59	135.48	164.83
	2010	256.41	255.27	257.56	221.27	183.25	266.13	158.02	143.23	173.97
	2011	252.18	251.06	253.31	215.63	177.85	260.32	154.91	140.27	170.73
	Slope (p-value)	**-4.19 (p<0.05)***			**9.30 (p<0.05)***				-0.86 (0.28)	
HEART DISEASE										
FEMALE	**2003**	69.50	68.99	70.02	74.86	64.80	86.82	70.04	62.59	79.68
	2004	67.23	66.73	67.73	73.41	63.46	85.26	70.13	62.49	79.97
	2005	68.88	68.39	69.39	70.77	61.04	82.40	64.86	57.51	74.46
	2006	66.26	65.77	66.74	74.53	64.58	86.38	75.78	67.15	86.66
	2007	64.54	64.07	65.02	73.13	63.41	84.75	65.22	58.12	74.56
	2008	63.73	63.27	64.20	76.56	66.46	88.58	76.57	68.74	86.63
	2009	60.53	60.08	60.98	76.25	66.39	88.00	74.05	66.39	83.94
	2010	60.92	60.48	61.36	77.77	67.85	89.59	61.72	54.99	70.73
	2011	60.46	60.03	60.90	86.33	75.50	99.10	67.33	60.62	76.29
	Slope (p-value)	**-1.24 (p<0.05)***			**1.20 (0.02)***				-0.28 (0.70)	
MALE	**2003**	122.91	122.04	123.79	130.85	101.79	166.83	165.93	151.76	182.19

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	2004	118.61	117.76	119.46	155.34	122.31	195.55	163.40	147.76	179.12
	2005	123.12	122.27	123.97	150.81	118.08	190.79	160.66	142.99	176.42
	2006	117.54	116.72	118.37	177.30	142.14	219.59	161.88	146.65	177.19
	2007	113.91	113.12	114.72	133.82	104.06	170.65	147.56	133.49	162.76
	2008	113.83	113.04	114.62	118.14	90.21	153.21	153.48	142.44	168.64
	2009	109.18	108.41	109.95	161.01	128.02	201.10	159.99	144.54	175.35
	2010	109.56	108.81	110.32	144.36	113.32	182.51	153.29	138.36	168.73
	2011	109.15	108.40	109.90	113.44	86.31	147.72	153.67	142.37	168.98
	Slope (p-value)	**-1.90 (p<0.05)***			-2.36 (0.46)			-1.47 (0.05)		
CEREBROVASCULAR										
FEMALE	**2003**	57.56	57.08	58.03	33.22	26.41	42.06	35.40	29.88	43.37
	2004	54.41	53.96	54.88	31.33	24.62	40.12	34.08	28.83	42.27
	2005	52.99	52.54	53.44	28.20	21.91	36.57	35.79	29.99	44.05
	2006	49.08	48.65	49.51	26.31	20.04	34.73	30.97	25.51	38.92
	2007	46.52	46.11	46.94	38.57	31.43	47.71	30.51	25.45	38.04
	2008	44.57	44.16	44.97	29.81	23.50	38.19	27.44	22.80	34.58
	2009	41.25	40.87	41.64	35.27	28.61	43.92	25.12	20.92	31.88
	2010	39.59	39.21	39.96	40.08	32.76	49.41	22.60	18.52	29.28
	2011	38.80	38.43	39.17	36.81	29.72	45.95	29.32	24.27	36.92
	Slope (p-value)	**-2.46 (p<0.05)***			0.97 (0.12)			**-1.39 (p<0.05)***		
MALE	**2003**	96.00	95.24	96.77	60.09	41.21	86.07	41.57	33.27	50.12
	2004	90.18	89.45	90.91	35.22	21.52	56.11	42.22	33.85	50.85
	2005	89.51	88.80	90.23	52.80	34.81	78.14	43.90	37.15	52.93
	2006	83.46	82.78	84.15	27.56	14.52	48.63	40.25	34.03	48.75
	2007	80.07	79.41	80.74	42.30	26.55	65.48	38.61	32.57	46.95
	2008	77.33	76.69	77.97	36.88	21.36	60.36	38.83	32.24	47.79
	2009	72.73	72.12	73.35	47.06	30.15	71.43	35.31	29.52	43.45
	2010	71.48	70.88	72.09	43.93	27.54	67.90	35.07	29.06	43.46
	2011	68.24	67.66	68.83	41.93	26.15	65.24	38.92	32.80	47.39

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Slope (p-value)		**-3.45 (p<0.05)***			-0.81 (0.55)			**-0.84 (0.01)***		
COMMUNICABLE										
FEMALE	**2003**	44.36	43.97	44.76	25.20	19.55	32.88	19.34	15.47	25.78
	2004	42.41	42.03	42.79	20.40	15.34	27.54	18.44	14.14	25.39
	2005	45.16	44.78	45.55	22.99	17.72	30.30	20.16	15.82	27.10
	2006	43.35	42.98	43.73	20.57	15.75	27.44	20.00	15.41	27.59
	2007	41.86	41.50	42.22	21.31	16.22	28.47	17.84	13.38	24.47
	2008	41.71	41.35	42.07	23.68	18.61	30.75	19.86	15.21	27.23
	2009	39.08	38.74	39.43	19.59	14.92	26.32	17.78	13.26	25.07
	2010	39.26	38.92	39.60	27.31	21.16	35.57	18.82	14.02	25.67
	2011	39.61	39.27	39.95	29.68	23.34	38.10	14.31	11.43	20.00
Slope (p-value)		**-0.70 (p<0.05)***			0.58 (0.21)			-0.45 (0.09)		
MALE	**2003**	95.28	94.54	96.03	34.95	20.69	56.69	31.00	25.09	39.29
	2004	92.11	91.40	92.84	33.84	20.19	54.84	30.39	24.89	38.23
	2005	98.07	97.34	98.80	31.54	17.39	53.65	32.90	26.93	41.24
	2006	92.28	91.59	92.98	35.09	21.14	56.41	34.54	28.66	42.75
	2007	90.61	89.94	91.28	39.56	24.26	62.37	26.87	22.23	33.88
	2008	89.74	89.09	90.40	41.26	23.92	66.95	33.19	27.37	41.38
	2009	84.28	83.66	84.91	19.75	9.36	38.20	28.22	23.34	35.49
	2010	85.71	85.09	86.33	33.55	18.80	56.39	29.95	24.86	37.43
	2011	85.56	84.96	86.18	25.95	13.49	46.49	28.27	23.45	35.49
Slope (p-value)		**-1.47 (p<0.05)***			-0.90 (0.32)			-0.38 (0.28)		

*Significant trends (p<0.05) are indicated in bold

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract – page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found – page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported – pages 4-5
Objectives	3	State specific objectives, including any prespecified hypotheses – page 5
Methods		
Study design	4	Present key elements of study design early in the paper- pages 6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection – pages 6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants – pages 6-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – page 8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group – page 8
Bias	9	Describe any efforts to address potential sources of bias – page 8
Study size	10	Explain how the study size was arrived at – page 9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions - pages 6-8
		(*c*) Explain how missing data were addressed –page 6-7
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy – page 8
		(*e*) Describe any sensitivity analyses –N/A

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed – N/A
		(b) Give reasons for non-participation at each stage – N/A
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders – pages 9-10, Table 1
		(b) Indicate number of participants with missing data for each variable of interest –N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) – N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time –N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure –N/A
		Cross-sectional study—Report numbers of outcome events or summary measures – pages 9-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included –pages 10-12, Table 2
		(*b*) Report category boundaries when continuous variables were categorized – page 10, Table 2
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period –page 12, Figure 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses – page 12
Discussion		
Key results	18	Summarise key results with reference to study objectives –page 12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias –page 16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence –pages 13-17
Generalisability	21	Discuss the generalisability (external validity) of the study results –page 6
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based –page 18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

This checklist has been completed and approved by:

Dr. Latha Palaniappan, MD, MS
Date: 4/8/2016