Why do Women Live Longer than Men?

A demographic analysis of male-female mortality differences in Okinawa and Japan

Donald Craig Willcox

ABSTRACT

During the 20th century the sex differential in life expectancy in the industrialized countries widened with women's lead over men expanding considerably. However, the 1970's saw a reversal of this trend with the gap between men and women actually shrinking in many industrialized countries. Japan has been a noted exception to this latter trend and has instead witnessed continued and persistent widening sex differentials. Within Japan, Okinawa prefecture has been famous for the long life expectancy of its citizens. However, life expectancy growth has slowed considerably in recent years such that compared to other prefectures, men in Okinawa live no longer than the Japan average. Although men in Okinawa have fallen to 26th place among the 47 prefectures, women still remain in first place, and there is a large difference in life expectancy between men and women.

The purpose of this study was to clarify the mortality and age group structure responsible for the gender gap in life expectancy in Okinawa and Japan. The life tables and vital statistics from 1975 to 2000 were used as the main source material. The results showed that gains in life expectancy at birth for Okinawa were smaller than Japan for both men and women over the period from 1975 to 2000. In addition the life expectancy gap between men and women in both Okinawa (from 6.81 to 8.37 years) and Japan (from 5.22 to 6.91 years) widened over this 25 year period. The growth in life expectancy for both men and women is currently coming mostly from the drop in mortality at older ages--particularly for ages 75 and older. The drop in mortality from cardiovascular diseases (CVD) made the most contribution to life expectancy gains in Okinawa and Japan. However, the drop in CVD was more remarkable for Japan than for Okinawa leading to relatively greater life expectancy gains in Japan. Mortality rates for the top six causes of death were all higher in men than in women--especially for suicide and accidents. Higher death rates from cancer (especially lung cancer), comparatively higher death rates from CVD (heart disease + stroke), and high suicide mortality for men were playing the most important role in the large gender gap in life expectancy between men and women in Okinawa.

Key words: life expectancy, sex difference, Okinawa, mortality, age-adjusted death rates

女性はなぜ男性よりも平均寿命が長いのか

沖縄と日本全国の平均寿命の年齢調整死亡率、年齢階級死亡率の男女差について

抄　録

20世紀、先進国においては平均寿命の性差が広がり、女性が男性を大きく引き離すようになった。ところが1970年代になると、性差が逆に縮小を始め、多くの先進国で性差が縮まっていった。その傾向にありながら、日本は例外的に性差がますます広がりつつある。沖縄県は、県民の平均寿命が高いことで知られてきた。しかしながら、最近では日本全国と比較すると平均寿命の延びが鈍化し、沖縄男性の平均寿命においてはもはや全国の平均寿命を下まわる。2000年に厚生労働省から発表された「都道府県別平均寿命」で沖縄県の男性の平均寿命が47都道府県の全国の内26位に順位を落としたものの、女性は平均寿命１位を維持し、男女間では大きな差がみられる。

本研究の目的は、沖縄と本土における平均寿命の性差の要因となる死亡率と年齢層の関係を明らかにすることである。本研究は1975年から2000年にかけての生命表及び人口動態統計を主に参考文献とした。その結果1975年から2000年もの期間において、男女共に沖縄は本土よりも平均寿命の伸びが鈍化したことを示した。さらに、この25年間の期間で、沖縄（6.81年から8.37年）と本土（5.22年から6.91年）両方で男女間における平均寿命の差が大きく広がった。現在における平均寿命の延びは男女共に、特に75歳以上の高齢者の死亡率の低下が大部分を占める。沖縄と本土において、循環器疾患（心疾患および脳血管疾患を含む）の死亡率の低下が平均寿命の延びに貢献した。しかしながら、循環器疾患の低下は、全国と比較して長寿だとされる沖縄よりも本土が顕著である。６大死因による死亡率は、全てにおいて女性より男性が高く、特に、不慮の事故（交通事故を含める）及び自殺率が高い。沖縄の男女間における平均寿命の大きな性差は、男性の悪性新生物（特に肺の悪性新生物）、比較的に高い比率の循環器疾患及び自殺などが重要な要因である。

キーワード：平均寿命、性差、沖縄、死亡率、年齢調整死亡率

INTRODUCTION

Since World War II, life expectancy at birth has increased in most countries around the world. In the mid-1970s Japan caught up to and then surpassed Sweden as the country with the longest life expectancy. In particular, Japanese women have been world leaders in average life expectancy since the mid-1980s and the difference between the second place countries has increased since that time (Yanagishita and Guralnik 1988). Women have a longer life expectancy than men in all developed countries, living 6 years longer than men on average (Gjonca et al 1999). Life expectancy at birth in 2000 in Japan was 77.71 years for men and 84.62 years for women (Ministry of Health, Labour and Welfare 2002).

Okinawa has been known for long life expectancy with women having the longest life expectancy at birth in Japan from 1980 and men being among the top five prefectures (first in 1980 and 1985) since reversion. However, life expectancy at birth for men declined to 26th place in 2000, a phenomenon referred to as "26 Shock" and life expectancy growth is among the slowest within Japan (slowest for men and second slowest for women from 1995-2000) (Japan Ministry of Health, Labour and Welfare 2002). It is thought that there are various factors contributing to this relative drop (compared to other prefectures) in life expectancy such as changes in dietary and activity patterns and other aspects of lifestyle (Willcox 2005). Although men in Okinawa have fallen to 26th place among the 47 prefectures, women still remain in first place, and there is a large difference in life expectancy between men and women (Ministry of Health, Labour and Welfare 2002).

Previous studies of the gender gap in life expectancy in Japan have been performed (Mizushima et al 2004; Watabiki and Nishida 1996; Yoshinaga 2005). However, studies of Okinawa prefecture, where the gender gap is largest in Japan, to our knowledge, have yet to be performed. Therefore, this study makes clear trends in the gender gap in life expectancy in Okinawa and Japan from 1975 to 2000, as well as the age-group differences and causes of death (mortality structure) responsible for the gender gap.

MATERIALS AND METHODS

Mortality statistics were gathered from Ministry of Health, Labour and Welfare Age-adjusted Death Rates by Prefecture for the years between 1975 and 2000 (Japan Ministry of Health, Labour and Welfare 2002). Life expectancy data was gathered from Prefectural Life Tables between the years 1975 and 2000 (Japan Ministry of Health, Labour and Welfare 2003). Further data was accessed from the Prefectural website (Okinawa Prefecture Department of Health and Welfare 2005). Finally, data from the Apple-Pineapple Project was utilized to look further into the relative contributions of age-groups and causes of death to the growth in life expectancy at birth since comparative data became available between Okinawa prefecture and other prefectures following reversion (from 1975 to 2000) (Hirao et al 2004).

Utilizing the above data-sets, sex differences in life expectancy at birth in Okinawa and Japan were calculated for 5 year periods from 1975 through 2000. Differences for men and women in age-adjusted death rates for the top 6 causes of death were analyzed to find male-female ratios for Okinawa and Japan in 1975 and 2000. Age-adjusted death rates for the years 1975 to 2000 for men and women were compared to examine changes in the 6 leading causes of death, which are : cancer, heart disease, cerebrovascular disease, accidents (including traffic accidents), pneumonia, and suicide. Changes in death rates from cancer (ratios) were calculated according to sex and type of cancer in Okinawa and Japan from 1975 to 2000. Changes in causes of death and age groups responsible for life expectancy growth were thus investigated for men and women in Okinawa and Japan over the last quarter century.

RESULTS

1. *Trends in the Gap in Life Expectancy between Men and Women (1975-2000)*

Figure 1 shows life expectancy at birth according to gender in Okinawa and Japan from 1975 to 2000. Life expectancy at birth was longer for women. Male life expectancy grew 5.49 years in Okinawa and 5.92 years in Japan from 1975 to 2000 while female life expectancy grew 7.05 years in Okinawa and 7.61 years in Japan. Life expectancy at birth for men in Okinawa was 0.36 years longer than the Japanese average in 1975 but had dropped to -0.07 years shorter by the year 2000. The life expectancy lead for women in Okinawa declined from 1.95 years to 1.39 years during the same period.

Figure 1 Life Expectancy at Birth for Men and Women (1975-2000)

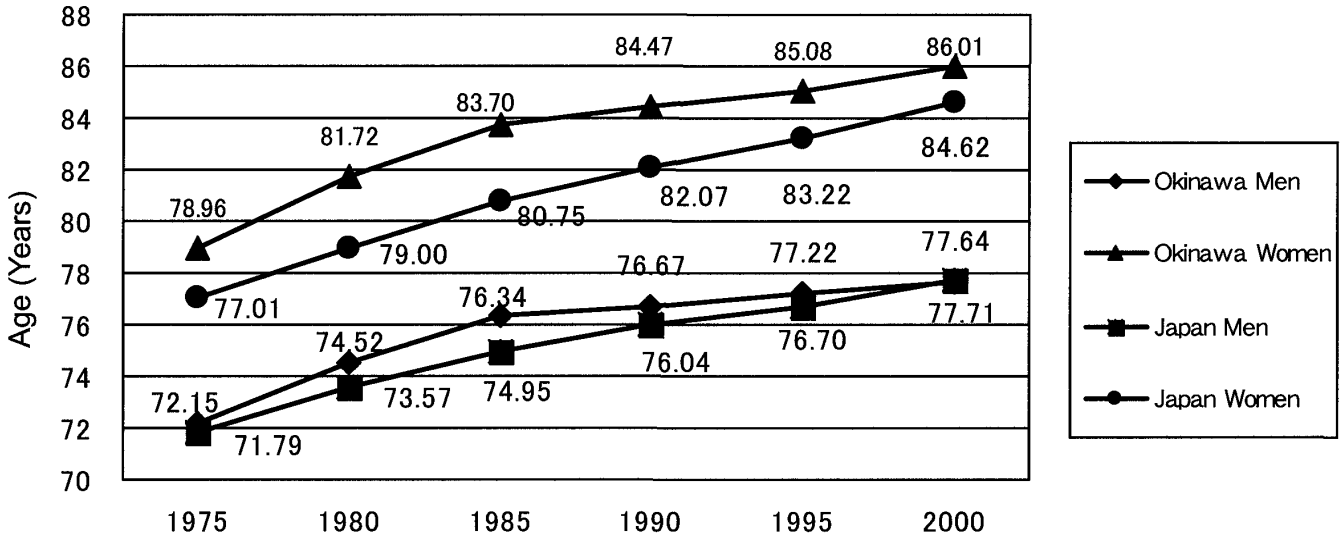


Table 1 shows rank of life expectancy by different ages for men in Okinawa and Japan. Although life expectancy at birth for men in Okinawa was 26th place among the 47 prefectures in Japan, life expectancy at age 65 years was the longest in the nation.

Table 1 Life Expectancy by Age for Men and Women (2000)

	0	20	40	65
Japan Men	77.71	58.32	39.13	17.56
Okinawa Men	77.64	58.42	39.50	18.45
National Ranking	26	23	9	1

	0	20	40	65
Japan Women	84.62	65.10	45.54	22.46
Okinawa Women	86.01	66.51	47.04	24.10
National Ranking	1	1	1	1

Figure 2 shows the difference in life expectancy according to age for men and women in Okinawa and Japan in 1995 and in the year 2000. The life expectancy lead for men in Okinawa shortened at all ages during this period. However, the older cohort, aged 65 and above, shortened the least and therefore retained much of their lead. Women in Okinawa had higher life expectancy from all ages but their lead at all ages also shortened between 1995 and 2000. Similar to the men, the highest lead was seen at 65 years and over. However, unlike the men the number 1 position was retained at all ages.

Figure 2 Life Expectancy Comparisons by Age for Men and Women

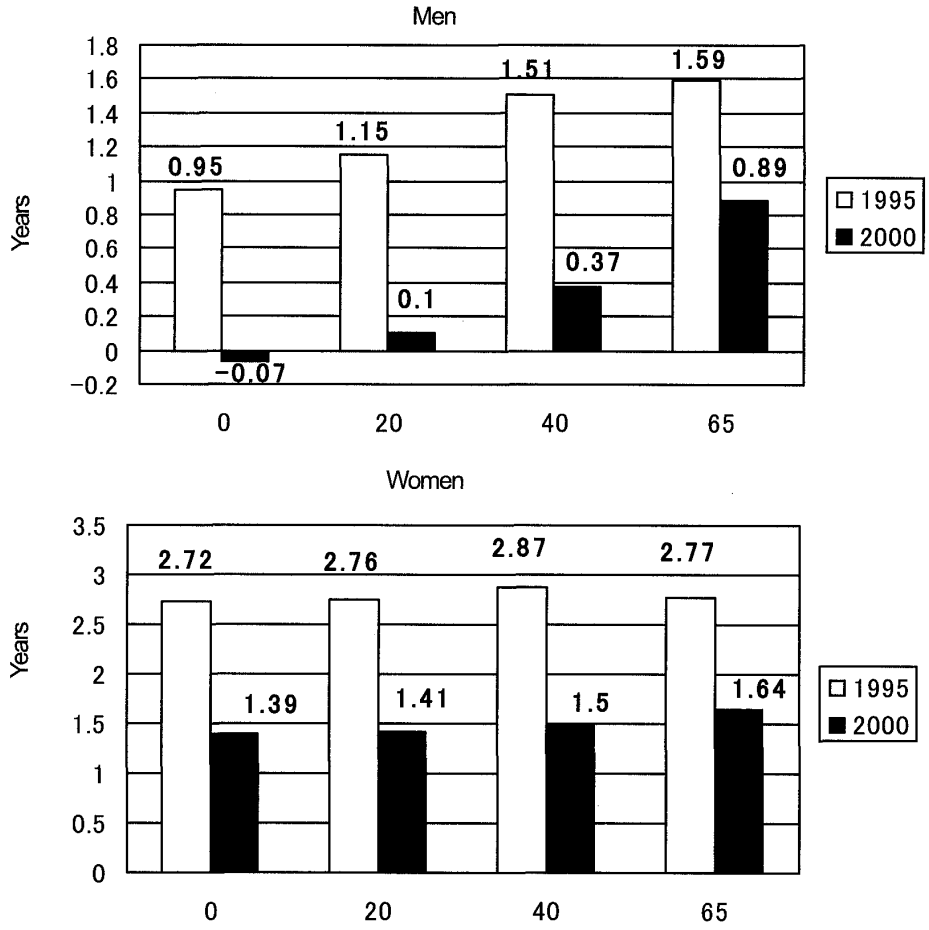
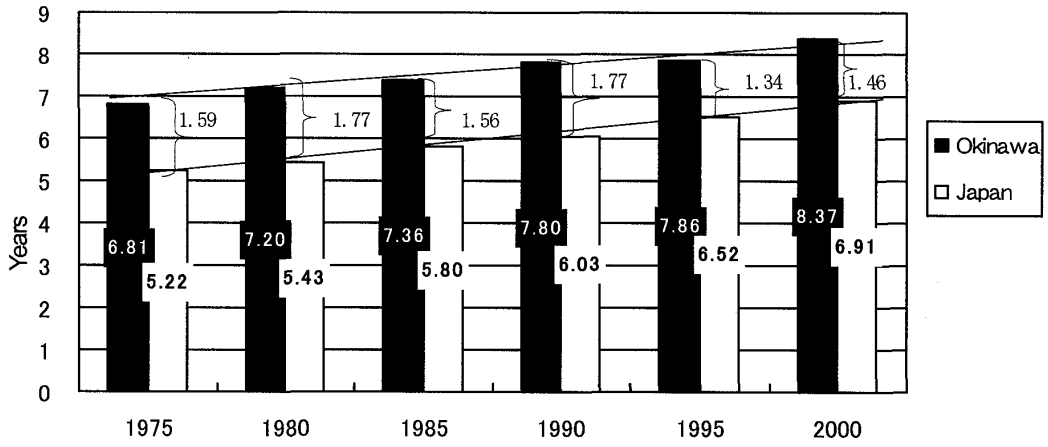


Figure 3 (below) shows the gender gap in life expectancy at birth in Okinawa and Japan. The gap in life expectancy for men and women in Okinawa rose from 6.81 years in favor of women to 8.37 years. The gap in Japan also rose, from 5.22 years to 6.91 years. Also, the gender gap difference between Okinawa and Japan declined from 1.59 years in 1975 to 1.46 years in 2000.

Figure 3 Sex Differences in Life Expectancy



2. *Trends in Age-Adjusted Death Rates (AADR) for the 6 Leading Causes of Death (1975 to 2000).*

Table 2 shows the sex ratio for the 6 leading causes of death in Okinawa and Japan in 1975 and 2000. In the year 2000, men in Okinawa had approximately two times higher total (all cause) mortality as well as about twice the mortality from cancer, heart diseases, cerebrovascular disease and pneumonia when compared to women. Mortality from accidents and suicide were about 4 times higher in men from Okinawa when compared to women. When analyzing changes from 1975 to 2000 we can see that the gender gap in Okinawa has grown with regards to every leading cause of death with accidents (including traffic) and suicide gaps increasing the most. The increasing gap between male and female suicide mortality over the years 1975 to 2000 also stands out for Japan as a whole.

Table 2 Age-Adjusted Death Rates for the 6 Leading Causes of Death (Male-Female Ratio)

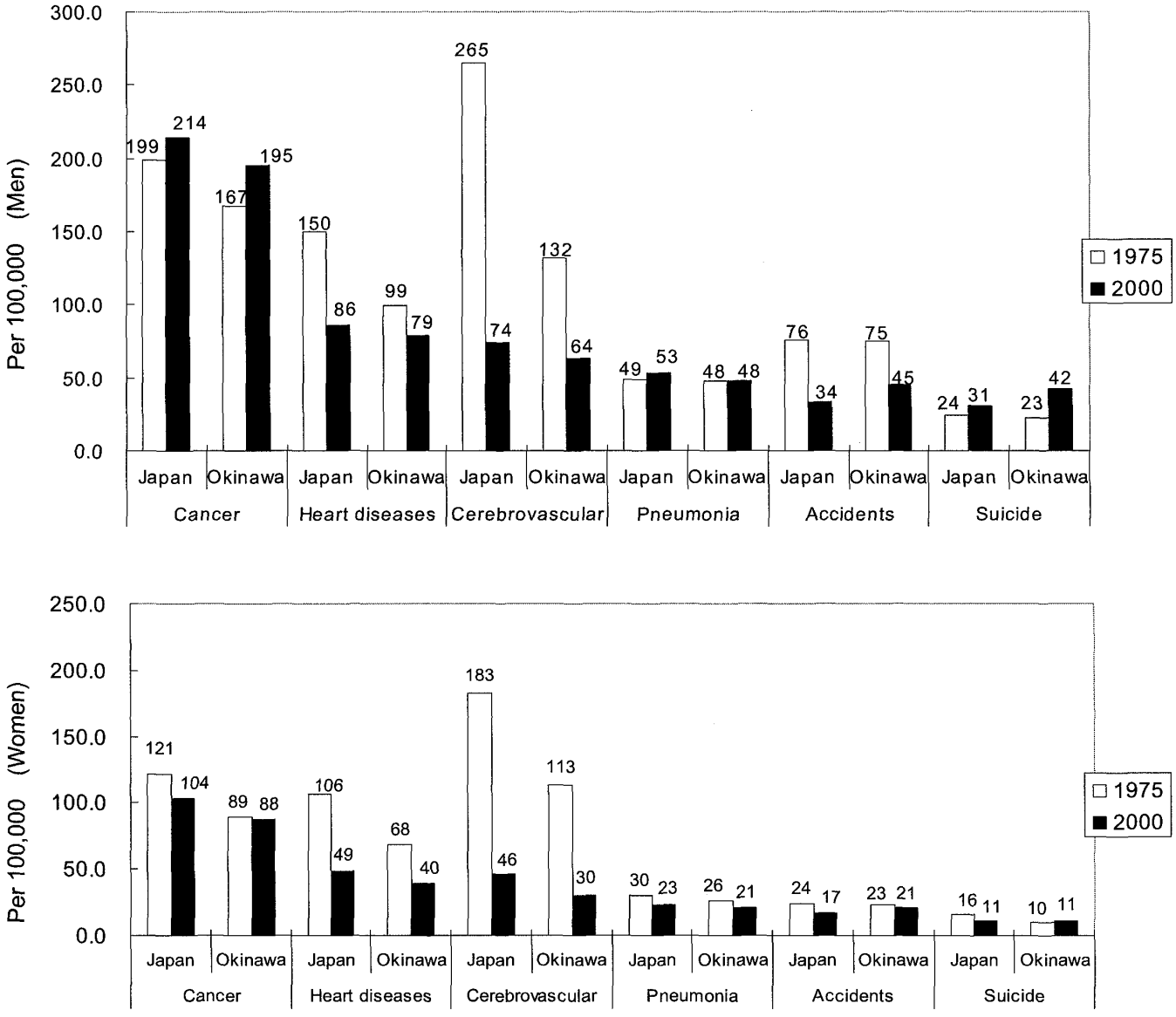
Causes	Okinawa		Japan	
	1975	2000	1975	2000
① Cancer	1.9	2.2	1.6	2.1
② Heart diseases	1.4	2.0	1.4	1.8
③ CVD	1.7	2.1	1.4	1.6
④ Pneumonia	1.9	2.3	1.6	2.3
⑤ Accidents	3.3	4.3	3.2	2.8
⑥ Suicide	2.4	3.8	1.5	2.9
⑦ All Causes	1.7	2.2	1.5	2.0

Figure 4 shows the change in the age-adjusted death rate (AADR) for the 6 leading (circa 2000) causes of death in 1975 and 2000 for men and women in Okinawa and Japan, respectively. Male death rates were higher than female death rates throughout this period. The AADR (per 100,000) for cancer in men in Okinawa increased from 167 in 1975 to 195 in 2000 but in Japan it increased less markedly from 199 to 214. In women, from 1975 to 2000, the AADR from cancer decreased in both Okinawa, which showed a slight decrease from 89 to 88 and Japan, which showed a more marked decease from 121 to 104. The AADR for heart diseases declined for both men (99 to 79) and women (68 to 40) in Okinawa but less markedly so than for men (150 to 86) and women (106 to 49) from Japan during this period.

The AADR for cerebrovascular diseases between 1975 and 2000 declined dramatically for men (190 to 64) and women (113 to 30) from Okinawa but even more impressive declines

were seen for men (265 to 74) and women (183 to 46) in Japan. The AADR for pneumonia increased slightly for men (49 to 53) from Japan but remained the same for men from Okinawa (48 to 48). However, death rates from pneumonia for women dropped in Okinawa (26 to 21) and Japan (30 to 23). The AADR for accidents (including traffic accidents) decreased for men (75 to 45) and women (23 to 21) in Okinawa and for men (76 to 47) and women (24 to 17) in Japan from 1975 to 2000. The AADR for suicide increased for men (23 to 42) in Okinawa and men (24 to 31) in Japan. However, in women from Japan, suicide declined (from 16 to 11) and in women from Okinawa suicide mortality stayed approximately the same, increasing only very slightly (10 to 11).

Figure 4 Age-Adjusted Death Rates for Men and Women



3. *Trends in Cancer from 1975 to 2000*

Figures 5 and 6 show the death rate according to sub-types of cancer for men and women in Okinawa and Japan. The leading cancer in 1975 for both Okinawa and Japan was stomach cancer. However, total percentage of cancer mortality attributable to stomach cancer dropped for both men (29.3% to 11.1%) and for women (19% to 8.4%) in Okinawa. A similar scenario can be witnessed for Japan with stomach cancer rates dropping from 39.9% to 18.3% for men and 32.9% to 15.3% for women in Japan. Ratios of colon cancer grew from 5.1% to 10.8% for men in Okinawa and from 6.7% to 11.8% for women in Okinawa. A similar phenomenon can be witnessed in Japan with colon cancer rising from 7.6% to 11.1% of total cancer mortality for men and from 9.7% to 13.8% in women. Liver cancer mortality was higher (almost double) in Japan compared to Okinawa in the year 2000 with rates having risen from 8.6% to 13.2% of total cancer mortality while remaining fairly stable as a total percentage in Okinawa. Liver cancer mortality rates have also risen for women in Japan (6.3% to 8.9%) as a percentage of total cancer mortality while they have dropped for women from Okinawa (7.7% to 4.5%). The ratio of breast cancer in Japanese women has slightly increased from 6.1% in 1975 to 7.9% in 2000. In women of Okinawa it has more than doubled from 3.8% in 1975 to 8.4% in 2000. The ratio of uterine cancer has dropped considerably in women from Okinawa (22% to 7.5%) and for Japan (10.2% to 4.5%) between 1985 and 2000. However, the ratio of lung cancer has increased in both men (18.2% to 28.2%) and women (8.7% to 17.7%) in Okinawa and in men (8.6% to 13.2%) and women (6.9% to 12.6%) from Japan.

Figure 5 Change in Death Rates from Cancer for Men (1975-2000)

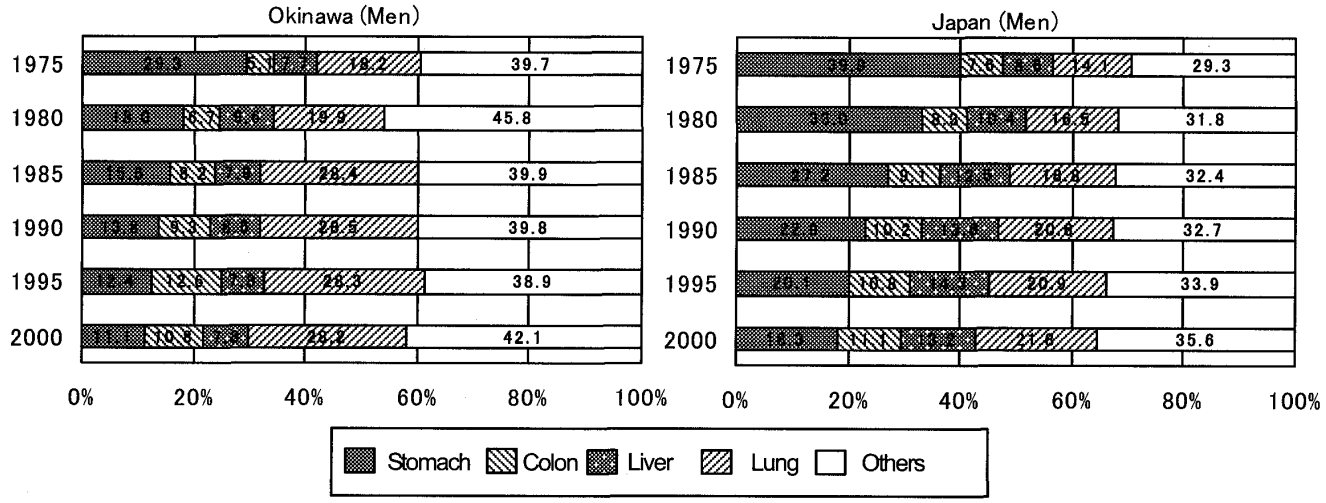
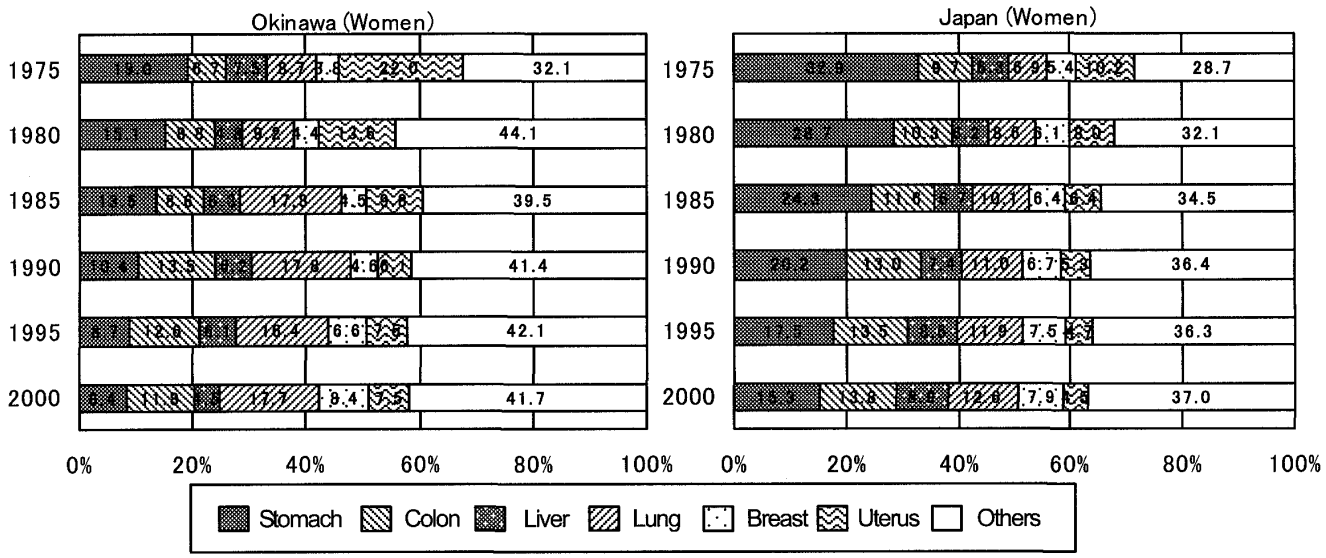


Figure 6 Change in Death Rates from Cancer for Women (1975-2000)



4. *Contributions of Age-groups and Causes of Death to Life Expectancy Growth from 1975 to 2000*

Figures 7 and 8 (based on Hirao et al 2005) show contributions to the growth in life expectancy by cause of death and by age group. The biggest contribution came from the decrease in cerebrovascular mortality at ages 35 and above. However, for men aged 35-64 years suicide mortality increased over the past couple of decades in both Okinawa and Japan causing a negative contribution. In addition, increasing mortality from cancer for those aged 75 and older caused a negative contribution to life expectancy in men and women in Okinawa.

Figure 7 Mortality Changes by Age Group Contributing to Life Expectancy Growth for Men

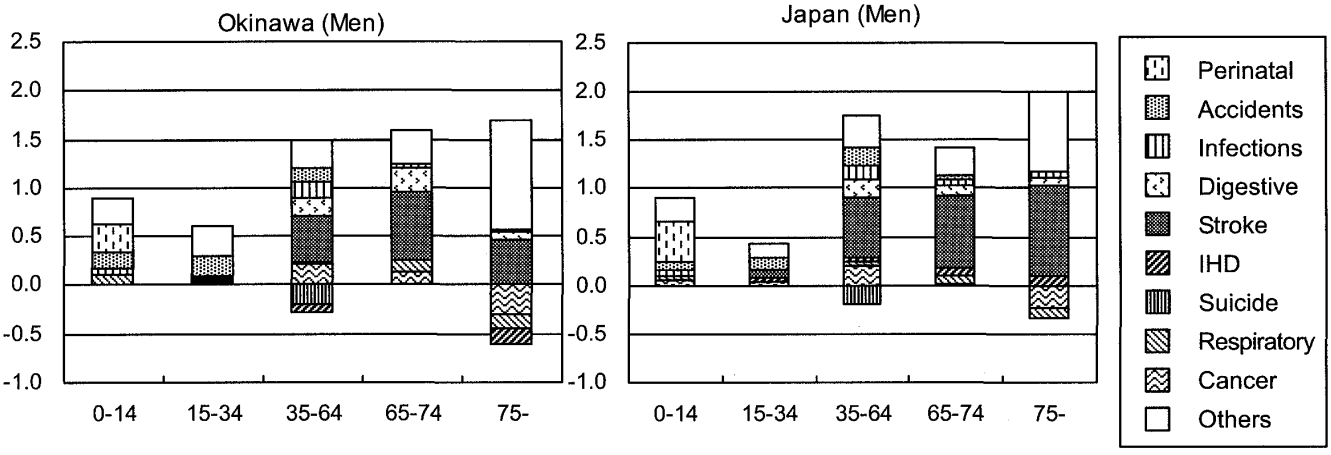
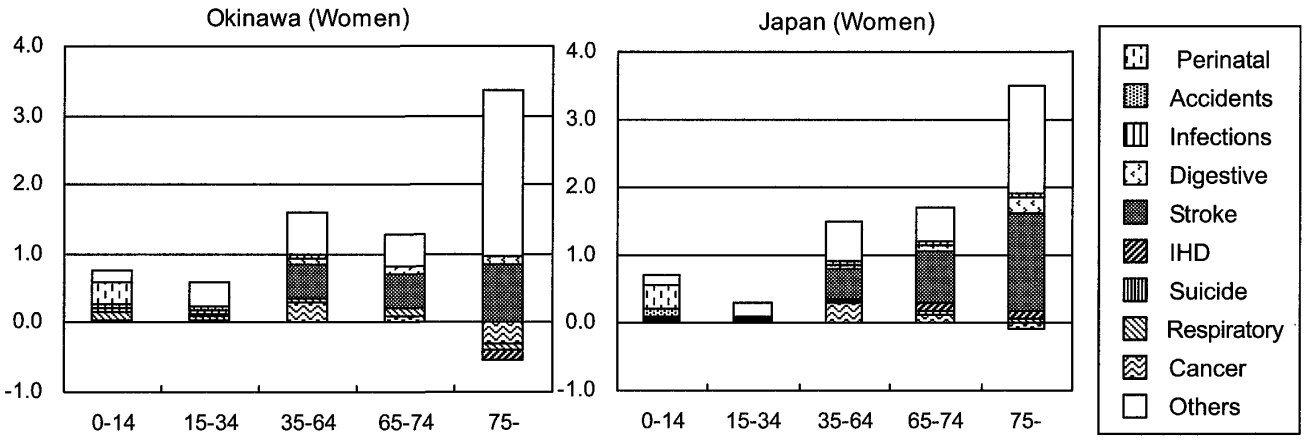


Figure 8 Mortality Changes by Age Group Contributing to Life Expectancy Growth for Women



5. *Contributions of Specific Cancers to Life Expectancy Growth at Birth from 1975-2000*

Figures 9 and 10 (based on Hirao et al 2005) show changes in mortality from specific sub-types of cancer contributing to the growth in life expectancy. The decline in mortality from stomach cancer made the most contribution to the growth in life expectancy for both men and women in Okinawa and Japan although women in Okinawa have declined in uterine cancer. However, lung cancer increased in men in Okinawa and Japan, and therefore lung cancer made a negative contribution to life expectancy growth. Liver cancer in men in Japan and Okinawa also made a negative contribution to the growth in life expectancy. Breast cancer mortality increases caused a negative contribution to life expectancy in Okinawa and Japan, particularly in women aged 35-64 years.

Figure 9 Cancer Mortality Changes by Age Group Contributing to Life Expectancy Growth for Men

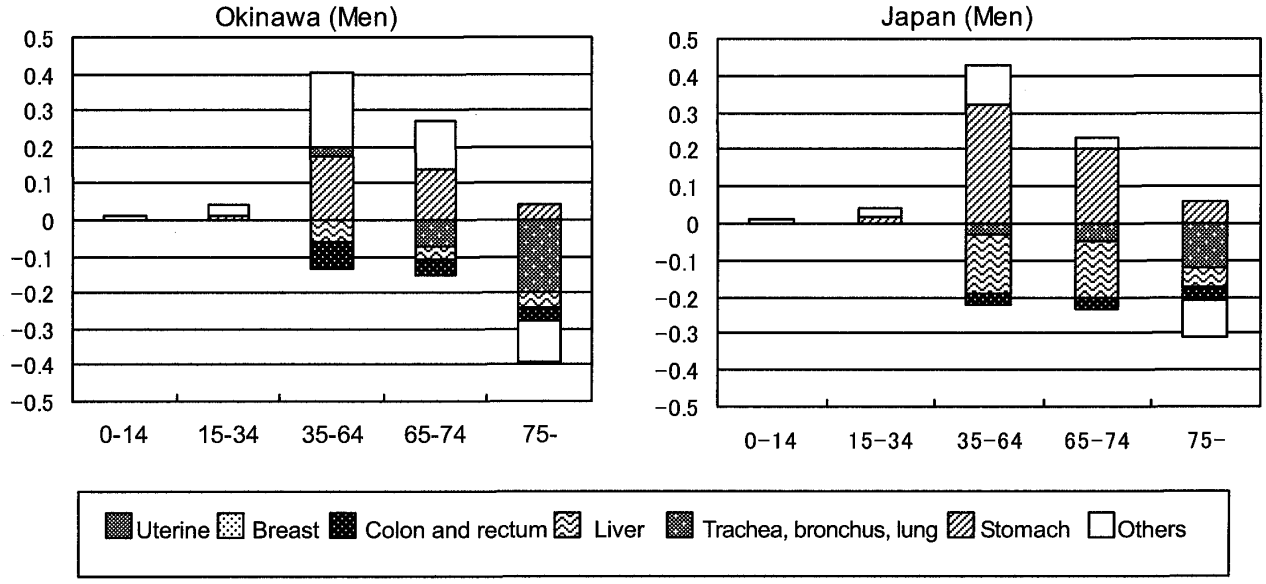
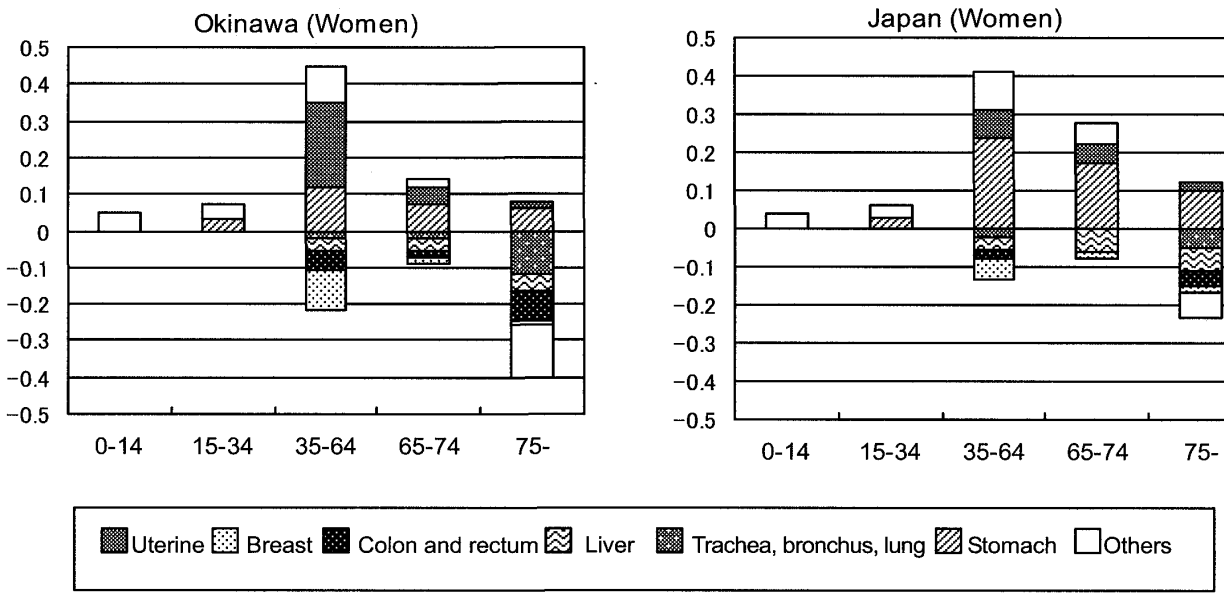


Figure 10 Cancer Mortality Changes by Age Group Contributing to Life Expectancy Growth for Women



6. *Contributions of Cerebrovascular Disease (CVD) to Life Expectancy Growth from 1975-2000*

Figures 11 and 12 (based on Hirao et al 2005) show contributions to life expectancy gains from mortality reductions according to type of CVD. Life expectancy gains from decreases in CVD in women 75 and older led to large gains in Okinawa, but especially so throughout Japan as a whole. Decreases in mortality from cerebral bleeding contributed most to life expectancy gains in Okinawa.

Figure 11 Changes in Stroke Sub-types by Age Group Contributing to Life Expectancy Growth for Men

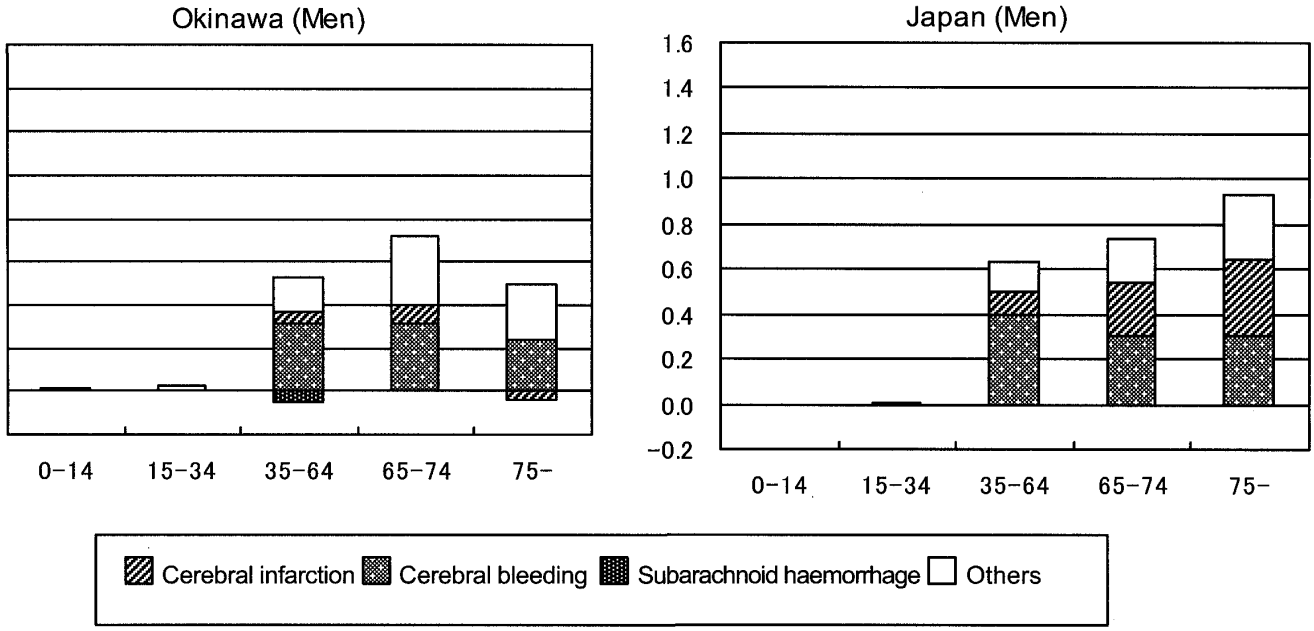
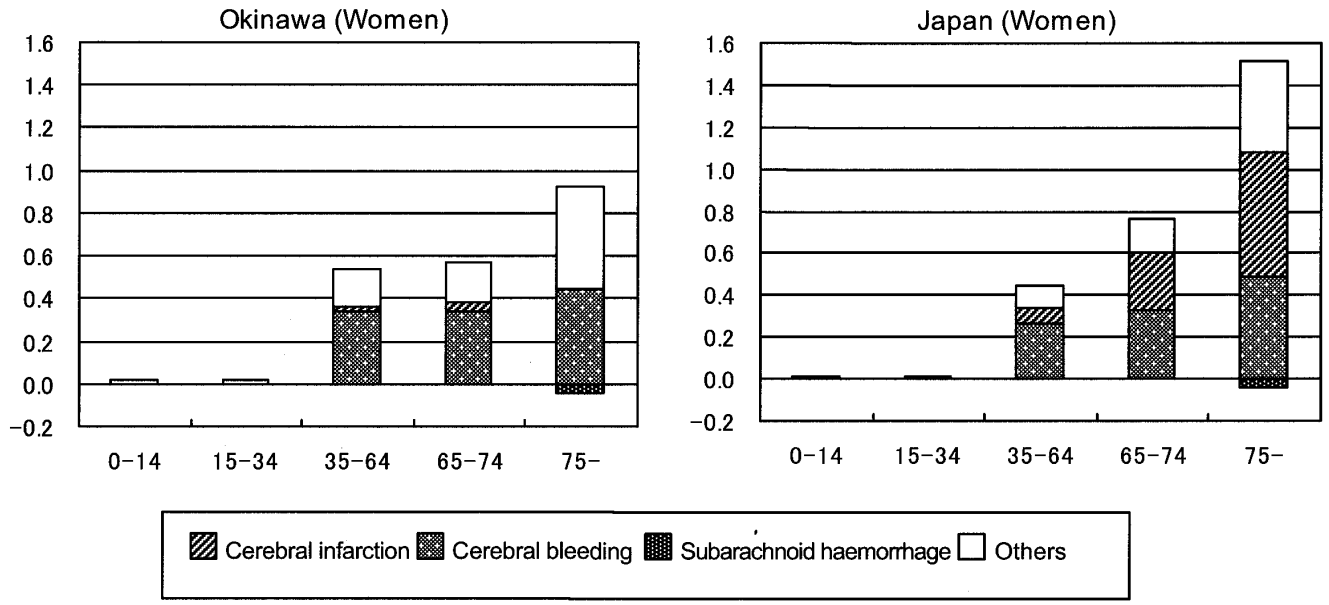


Figure 12 Changes in Stroke Sub-types by Age Group Contributing to Life Expectancy Growth for Women



DISCUSSION

In the late 1970's, life expectancy at birth for men and women in Okinawa was the longest within Japan, which was in turn, the world's longest lived country. Arguably, this would make the citizens of Okinawa prefecture the world's longest lived people. Women in particular had extremely impressive numbers and were even then outpacing the men. Since then, the growth in life expectancy at birth for men and women has been even larger for women compared to men and this has contributed to an ever increasing gender gap. The growth of life expectancy at birth for men in Okinawa was smaller than for Japan, particularly after 1990, and this trend, combined with the small lead for men from Okinawa over other prefectures in the first place, caused the prefectural ranking of life expectancy at birth in Okinawa for men to drop from 1st to 26th place by the year 2000.

However, women from Okinawa had a bigger lead in life expectancy at birth over women from mainland Japan, therefore growth in life expectancy at birth in Okinawa, although 2nd slowest (46th place) in Japan between 1995 and 2000, did not affect prefectural ranking of women from Okinawa who were able to retain the number 1 position (at all ages). However, at the current pace of life expectancy growth and decreasing lead for women from Okinawa at all age groups, it appears only a matter of time before women also fall from first place in life expectancy at birth. As well as the difference in length of life expectancy between men and women, a difference in improvement of speed of life expectancy growth also seems to have contributed to the expansion of gender gap in life expectancy in Japan and Okinawa.

Age adjusted death rates for cerebrovascular diseases and heart diseases have dropped considerably since 1975. Therefore, these causes have gradually been playing a relatively less important role in the gender gap than has cancer, which by far accounts for the largest share of mortality, and suicide, and which has seen a considerable increase in mortality since 1975. Cancer, by far, contributes the most (percentage) to total mortality. Furthermore, men also had double the cancer rates of women. Therefore, it is thought that the contribution of cancer is the most important factor in bringing about the gender gap of life expectancy at birth in Okinawa and Japan. Yoshinaga (2005) also reports similar findings for Japan as a whole.

When analyzing the contribution of specific age groups, it was seen that decreasing mortality from cancer in men and women under 75 years (especially ages 35-74) in both Okinawa and Japan was making positive contributions to life expectancy increases in both men and women. Stomach cancer mortality dropped considerably in importance as a cause of cancer mortality in both men and women in Okinawa and Japan.

As for the reasons, changes in Japanese lifestyle including eating habits (especially lower salt intakes), discovery and treatment for H. Pylori, and early discovery-treatment of stomach cancer by better medical technology are thought to be important contributing factors (Watabiki 1996; Yoshinaga 2005; Health, and Welfare Statistics Association 2005). However, increasing lung cancer mortality in men and women in Okinawa and Japan was making negative contributions to life expectancy gains. These negative contributions were coming mainly in men and women aged 75 and over and also contributed in large part to the gender gap. Negative contributions were also coming from increases in deaths from liver cancer for men aged 35 years and older in Okinawa and Japan with men having two times the negative contributions of women. In addition, contribution of uterine cancer for growth in life expectancy at birth became important for women because the death rates from uterine cancer decreased year by year.

As for the reason why women are doing so much better then men in these areas, differences in risk-taking health behaviors, particularly smoking and drinking habits, are thought to be major factors in causing the gender gap (Willcox 2005; Okinawa Prefecture Department of Health and Welfare 2005; Hirao et al 2005; Kamada et al 2000; Wakai 1997).

The decrease of AADR's from cardiovascular diseases (heart diseases and stroke), especially that of stroke, were the most remarkable of all changes seen over the period of 1975 to 2000, and contributed the most to gains in life expectancy since reversion. Gains for women from Okinawa and Japan from reduced stroke mortality were even more impressive than for men and this helped to widen the gender gap with women aged 75 and over gaining the most in terms of added years. The life expectancy gains for older women from Japan (75 and over) were truly remarkable.

Finally, an increasingly worrisome trend is that of increasing suicide rates for men aged 35-64 years in Okinawa and Japan. Suicide, following cancer, was the single-most important factor in the wide gender gap seen between men and women in Okinawa in the year 2000. Moreover, the increasing tendency of the AADR for suicide between 1975 and 2000 stands out as a potential factor that could further increase gender gaps in Okinawa as well as life expectancy gaps between Okinawa and Japan in the future. Healthier lifestyles by men in mid-life or earlier would no doubt help to reduce mortality as men age and therefore reduce the gender gap, as can be seen in other populations (Willcox et al 2006). Community wide prevention programs that promote healthier food choices and higher activity levels and that target male health behaviors in the areas of work-related stress would no doubt help to reduce the current high levels of obesity, smoking and alcohol consumption patterns and risk-taking behavior that may be directly or indirectly related to the unacceptably high rates of cancer (especially lung cancer), cardiovascular disease and suicide in men in Okinawa and that are contributing to an ever expanding gender gap in life expectancy.

CONCLUSIONS

1. Life expectancy grew at a faster pace in Japan compared to Okinawa from 1975 to 2000.
2. The gender gap widened in Okinawa (and Japan) during this period.
3. Men had approximately two to four times higher mortality rates than women for all 6 leading causes of death in both Okinawa and Japan from 1975 to 2000.
4. The largest contribution to the overall extension of life expectancy in both men and women in Okinawa and Japan from 1975 to 2000 came from the drop in cerebrovascular disease, particularly in women aged 75 and older.
5. Cancer (esp. lung cancer), CVD (heart disease plus stoke) and suicide were the most important causes of death contributing to the gender gap in Okinawa in the year 2000.

Acknowledgements

I would like to acknowledge those who supported me in this study such as Ms. T. Asato, Ms. M. Takara, Drs. Hirao and Todoriki, as well as the Apple-Pineapple Project for access to helpful data. This project was supported, in part, by a grant from the Japan Society for Promotion of Science to Dr. Donald Craig Willcox.

REFERENCES

Gjonca A, Tomassini C, Vaupel JW: Male-female differences in mortality in the developed world. Max Planck Institute for Demographic Research Working Paper WP 1999-009: 1-9; 1999. Accessed online at www.demogr.mpg.de.

Health and Welfare Statistics Association: Recent Cancer Trends. Journal of Health and Welfare Statistics 52 (9): 45-47; 2005. (In Japanese).

Hirao T et al: Apple-Pineapple Project Final Report; 2005 (In Japanese).

Japan Ministry of Health, Labour and Welfare: Age-Adjusted Death Rates by Prefecture, Special Report on Vital Statistics 2000; 2002. (In Japanese).

Japan Ministry of Health, Labour and Welfare: Prefectural Life Tables 1980～2000; 2003 (In Japanese).

Kamada A, Watabiki S, Nishida S: A study on the life expectancy at birth in Aomori prefecture. Public Health Research 49: 62-71; 2000. (In Japanese).

Mizushima Y, Mizuno H, Urada Y: The influence of the top cause of death on life expectancy among prefectures in Japan. Gerontology 16: 65-69; 2004. (In Japanese).

Okinawa Prefecture, Department of Health and Welfare, Division of Health Promotion: 26 Shock! 2005. Accessed online at http://www.kenko-okinawa.jp/kankobutu/26shock. (In Japanese).

Wakai K, Ohno Y, Genka K, et al.: Smoking habits, local brand cigarettes and lung cancer risk in Okinawa, Japan. Journal of Epidemiology 7: 99-105; 1997.

Watabiki S, Nishida S: The sex differential in life expectancy at birth in recent decades in Japan. Public Health Research 45: 139-149; 1996 (In Japanese).

Willcox BJ, He Q, Chen R, Yano K, Masaki KH, Grove JS, Donlon TA, Willcox DC, Curb JD: Midlife risk factors and healthy survival in men. Journal of the American Medical Association 296: 2343-50; 2006.

Willcox DC: Okinawan longevity: Where do we go from here? Journal of Nutrition and Dietetics 8: 9-17; 2005.

Yanagishita M, Guralnik JM: Changing mortality patterns that led life expectancy in Japan to surpass Sweden's: 1972-1982. Demography 25: 611-624; 1988.

Yoshinaga K, Une H: Contributions of mortality changes by age group and selected causes of death to the increase in Japanese life expectancy at birth from 1950 to 2000. European Journal of Epidemiology 20: 49-57; 2005.