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A progressive rise in stomach cancer-related mortality rate during 1970–1995 in Japanese individuals over 85 years of age

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A large number of studies have shown a gradual fall in stomach cancer-related mortality rate during the last decade. Here we analyzed the pattern of stomach cancer-related mortality rates in Japanese aged >85 years from 1970 to 1995. We used data for the entire population of Japan. The magnitude of change was measured by relative risk and cause-elimination life tables to distinguish time trends in mortality rates of stomach cancer for individuals over 85 years of age compared with other age groups (55–84 years). In the over-85 age group, stomach cancer mortality increased from 374 in 1970 to 662 in 1995 per 100,000 (77%) for males and from 232 to 296 per 100,000 (27%) for females. Using the 55–59 years group as the reference category, the relative risk increased from 2.3 to 9.9 and from 2.8 to 11.1 in men and women, respectively. The effects of mortality on life expectancy also increased 1.5 times and 1.1 times, respectively. Our results showed a rise of stomach cancer mortality in Japanese aged over 85 years, which paralleled the increase in relative risk and negative contribution to life expectancy. While the mortality of younger age groups is decreasing, the change over from increase to decrease in the over-85 age group is only just beginning.

Keywords: stomach cancer; mortality; age; Japan; old

1. Introduction

A continuing marked fall in stomach cancer-related mortality rates, dissimilar to other cause-related mortality rates [2–4,10,19,20,23,], has been observed over the last few decades [11,12,24]. In the USA, the proportion of cancer deaths among men attributable to stomach cancer decreased from 24.6% in the 1930s to only 2.9% in 1990, while a decrease from 14.5% to 2.2% occurred among women during the same period [27]. In the European Union, stomach cancer rates for both

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genders have decreased by 30% during the last decade of the 20th century [15]. For example, in the Netherlands, stomach cancer-related mortality declined from 19.9 to 13.9 per 10^6 person-years in men between 1989 and 1998, with a similar percentage decline in women, although absolute numbers were much less (7.9–5.6 per 10^6 person-years) [14]. However, in Portugal, the estimated annual percent change (EAPC) from 1988 to 1998 was only −2.2% for both genders [27]. As in most industrial countries, a major decrease in stomach cancer-related mortality has also been evident in Japan [22,26,28].

It has been reported that the consumption of green tea [8] and dietary factors, such as decreased sodium intake and increased vitamin C intake [25], are potentially preventive of stomach cancer. In addition, food additives [16,18] and *Helicobacter pylori* [17] have been investigated as potential factors affecting the incidence of stomach cancer. Further, in a population-based study, epidemiologists noted the effectiveness of screening programs in reducing stomach cancer-related mortality in Japan [9].

In the late 20th century, reports insist that stomach cancer-related mortality has been consistently declining among all age and gender population subgroups [5]. The purpose of the present study was to show the pattern of stomach cancer-related mortality rates with regard to age in the Japanese population. Our results indicate that the inflexion point from rising to decreasing stomach cancer rates occurred in the group aged >85 years.

2. Methods

To study stomach cancer-related mortality for the entire population of Japan, we collected the data for the total population of Japan, including the total number of deaths categorized by age and gender, and the stomach cancer-related mortality rate by gender in age group increments of 5 years. These data were obtained from the 'Journal of Health and Welfare Statistics', compiled by the Health and Welfare Statistics Association, Japan. Separate analyses were performed for the rates during 1970–1995 and 1996–2001 because the population over 85 years prior to 1995 was very small, although individuals aged >85 years constituted the oldest age group for 1975–1995. Concurrent with a swift increase in the average life expectancy in Japan, the population over 85 became substantially larger for 1996–2001, which led to the group aged over 85 years being classified further into two subgroups: (1) 85–90 years and (2) > 90 years.

Age-specific stomach cancer-related mortalities were plotted and linear fitting was carried out on the same graph to examine the effect of age.

Life expectancy tables for the general population were used to quantitatively estimate the impact of death due to stomach cancer on lifespan. In demography, the effects of eliminating diseases are studied through the use of cause-elimination life tables. In such life tables, the cause of death is eradicated and the life expectancy is then recalculated. Thus, the effect of death from stomach cancer on overall life expectancy was calculated using cause-elimination life tables with the crude probability of death, providing a more accurate assessment of the impact of changing stomach cancer-related deaths compared with the relative changes in mortality rates over time. The analysis was carried out separately for men and women. Life tables were constructed in an abridged form based upon 5-year intervals, except for the first 5 years of life.

Cohort curves for age-specific stomach cancer-related mortality rates were examined to quantify the direction and magnitude of stomach cancer-related mortality trends between 1996 and 2001. EAPC was used as an estimate of the trend [6]. Using the calendar year as an independent variable, a regression line was fitted to the natural logarithm of the rates using the following equation:

$$y = mx + b,$$

where $y = \ln$ (rate) and $x =$ the calendar year. From this, EAPC $= 100 \times (e^m - 1)$.

All statistical analyses were performed using SPSS (SPSS Inc., Chicago, IL, USA) and Excel (Microsoft Corp, Redmond, WA, USA).

3. Results

The age-specific stomach cancer-related mortality rates from 1970 to 1995 show a progressive and significant decline for both genders for ages under 85, with specific reductions in mortality rates for the 55–59, 65–69, and 75–79 age groups from 159.2 to 66.7, 412 to 174.4, and 640.1 to 364.4 per 100,000 in men, and from 82.5 to 26.6, 177 to 56.4, and 317.2 to 125.8 per 100,000 in women, respectively (Figure 1). The exception to this trend was the stomach cancer-related mortality rate for the group aged >85 years over the same period, which rose significantly from 374.2 to 662.4 per 100,000 (77%) for men and from 232.5 to 295.7 per 100,000 (27%) for women.

Table 1 shows the results of the risk analyses of men and women relative to the 55–59 age group. The relative risk for stomach cancer among men under 80 remained fairly constant throughout the period 1970–1995, but was highest in the 75–79 years age group in 1970, the 80–84 years age group in 1975 and 1980, and in the over-85 age group after 1985. The relative risk in subjects over 80 years continued to increase throughout the entire period. With the over-85 age groups, the

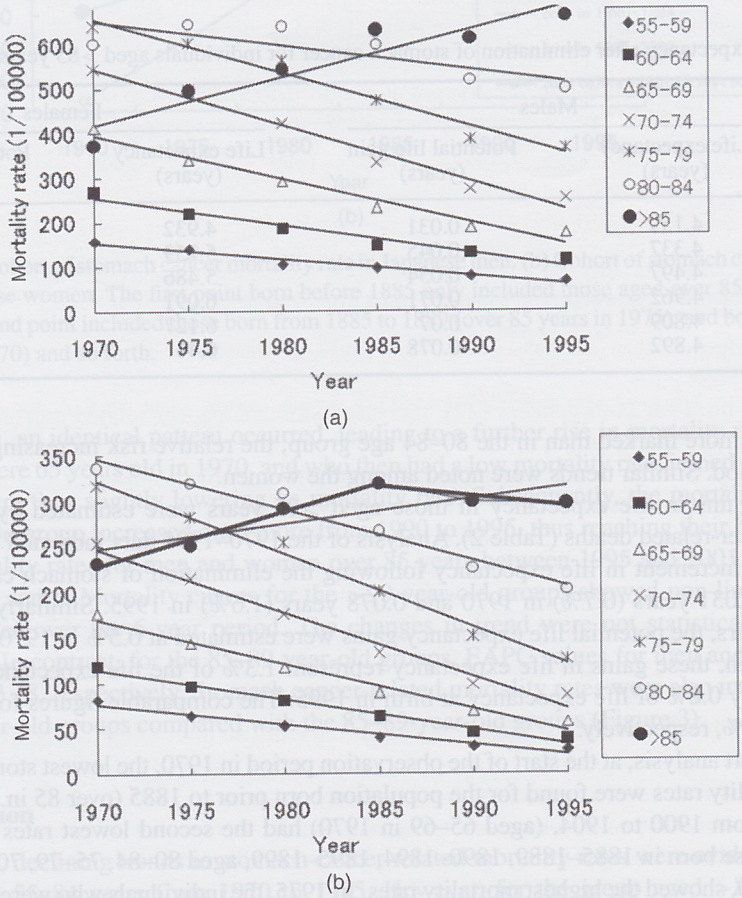

Figure 1. (a) Time trends for age-specific stomach cancer mortality rates for Japanese men. (b) Time trends for age-specific stomach cancer mortality rates for Japanese women. Lines shown are calculated linear regression lines.

Table 1. Relative risks for stomach cancer by age and gender using age group 55–59 years as the reference category.

	1970	1975	1980	1985	1990	1995
Males						
55–59	–	–	–	–	–	–
60–64	1.682	1.568	1.764	1.539	1.666	1.681
65–69	2.588	2.421	2.769	2.404	2.357	2.615
70–74	3.424	3.517	4.001	3.474	3.458	3.78
75–79	4.021	4.292	5.349	4.919	4.874	5.463
80–84	3.784	4.605	6.064	6.234	6.542	7.432
>85	2.351	3.52	5.161	6.557	7.733	9.931
Females						
55–59	–	–	–	–	–	–
60–64	1.45	1.509	1.537	1.588	1.507	1.398
65–69	2.145	2.244	2.22	2.221	2.287	2.12
70–74	3.067	3.328	3.315	3.322	3.27	3.207
75–79	3.845	4.392	4.801	5.005	5	4.729
80–84	4.069	4.97	5.856	6.668	7.53	7.598
>85	2.818	3.907	5.531	8.003	9.923	11.117

Table 2. Life expectancy after elimination of stomach cancer for individuals aged >85 years.

	Males		Females	
Year	Life expectancy (years)	Potential life gain (years)	Life expectancy (years)	Potential life gain (years)
1970	4.159	0.031	4.932	0.028
1975	4.337	0.045	5.259	0.034
1980	4.497	0.054	5.486	0.043
1985	4.962	0.071	6.091	0.054
1990	4.809	0.07	6.127	0.054
1995	4.892	0.078	6.46	0.058

increase was more marked than in the 80–84 age group; the relative risk increasing 4-fold over the study period. Similar trends were noted among the women.

Potential gains in life expectancy in those aged >85 years were estimated by eliminating stomach cancer-related deaths (Table 2). Analysis of the 1970–1995 data indicated that for men, the potential increment in life expectancy following the elimination of stomach cancer-related deaths was 0.031 years (0.7%) in 1970 and 0.078 years (1.6%) in 1995. Similarly, for women aged >85 years, the potential life expectancy gains were estimated at 0.5% in 1970 and 0.9% in 1995. For men, these gains in life expectancy represent 1.3% of the life expectancy at birth in 1970, but only 0.8% of life expectancy at birth in 1995. The comparable figures for women are 0.9% and 0.5%, respectively.

In the cohort analysis, at the start of the observation period in 1970, the lowest stomach cancer-related mortality rates were found for the population born prior to 1885 (over 85 in 1970), while those born from 1900 to 1904, (aged 65–69 in 1970) had the second lowest rates (Figure 2a). However, those born in 1885–1889, 1890–1894, 1895–1899, aged 80–84, 75–79, 70–74, respectively, in 1970, showed the highest mortality rates. In 1975, the individuals who were 80–84 years old in 1970, and had shown a high mortality rate then, were now placed into the >85 years group, resulting in an increased mortality rate among this group. Similarly, in 1980, those individuals who were 75 years old in 1970 were added to the >85 years group, further augmenting the mortality

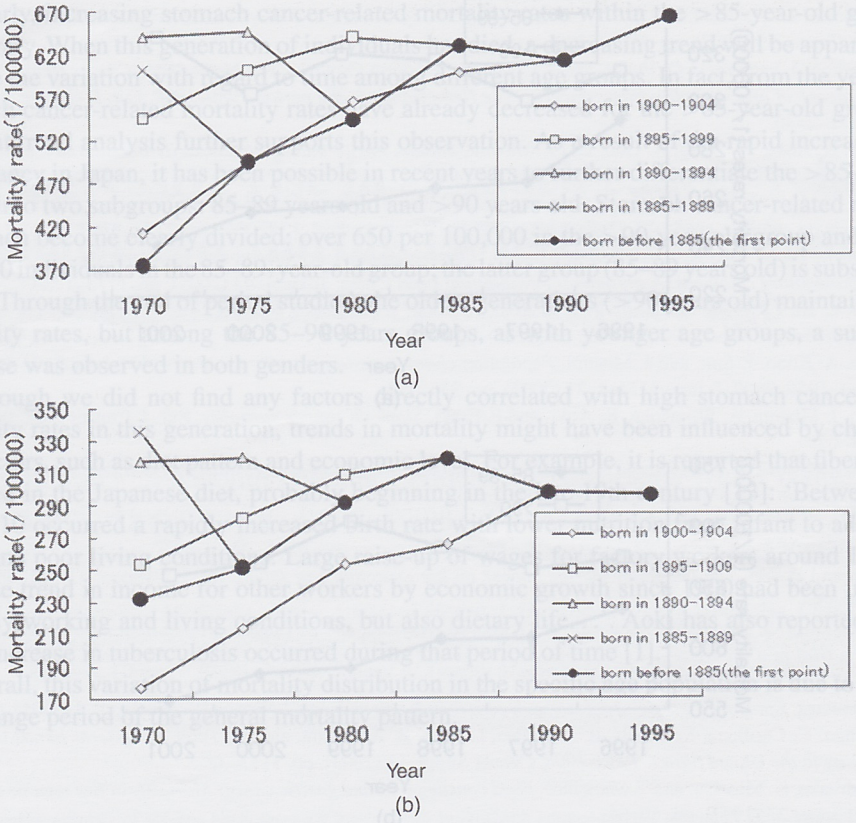

Figure 2. (a) Cohort of stomach cancer mortality rate in Japanese men. (b) Cohort of stomach cancer mortality rate in Japanese women. The first point born before 1885 only included those aged over 85 years in 1970, while the second point included those born from 1885 to 1889 (over 85 years in 1975), and born before 1885 (over 85 in 1970) and so forth.

rate. In 1985, an identical pattern occurred, leading to a further rise in mortality rates. In 1990, those who were 65 years old in 1970, and who then had a low mortality rate, joined the >85 years old age group, thus slightly lowering its mortality rate. Subsequently, the mortality rate of the >85 years old group increased once more from 1990 to 1995, thus reaching their highest level.

The mortality rates for men and women over 85 years between 1995 and 2001 are presented in Figure 3a and b. Mortality curves for the >90-year-old groups showed non-linear variations for both sexes over the 6-year period. The changes in trend were not statistically significant ($p > 0.05$). In contrast, for the 85–89-year-old groups, EAPC values for men and women were –2.25 and –3.18, respectively. Stomach cancer-related mortality rates were also much higher for the >90-year-old groups compared with the 85–89-year-old groups (Figure 3).

4. Discussion

In this study, declining trends in stomach cancer-related mortality rates were evident among the groups aged 55–84 years from 1970 to 1995. However, for the group aged >85 years, both male and female mortality increased throughout the observation period 1970–1985. The magnitudes of these changes in mortality rates were also reflected in the analyses of life expectancy. Although decreased stomach cancer-related mortality rates led to significant improvements in life

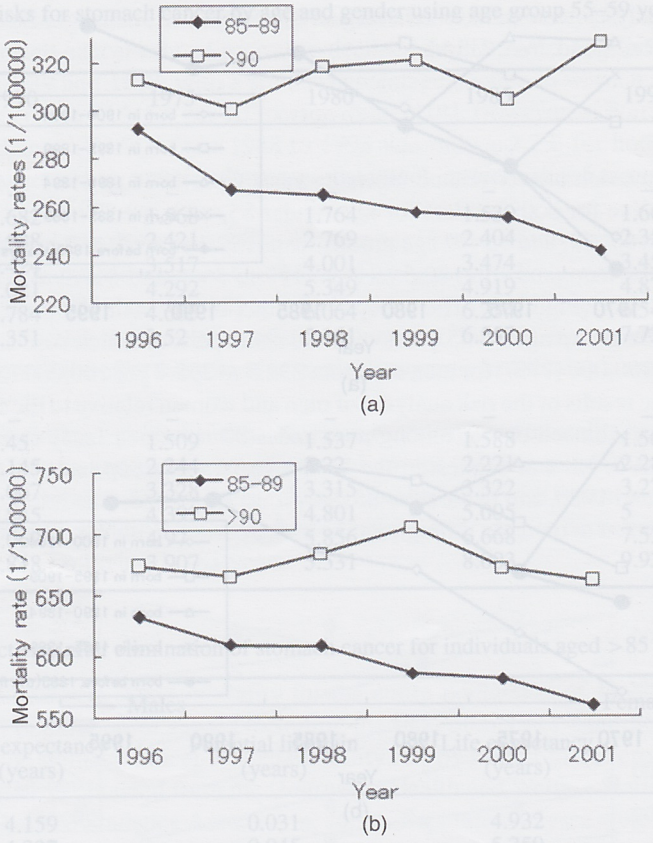

Figure 3. (a) Trends in mortality rate due to stomach cancer in Japanese women (1996–2001). (b) Trends of mortality rate due to stomach cancer in Japanese men (1996–2001).

expectancy at birth for both genders [22], increased stomach cancer-related mortality rates led to a decline in life expectancy for the >85-year-old groups during the observation period. The potential life expectancy among men increased in the >85-year-old groups, but decreased at birth. Such opposing trends in life expectancies were even more evident among women, increasing from 0.5% to 0.9% for the >85-year-old groups and decreasing from 0.9% to 0.5% at birth.

While the relative risk for stomach cancer for the >85-year-old group increased sharply, within the second most elderly age group (80–84 years old), the increase was only slightly greater compared with the group aged 55–59 years. A cohort analysis indicated that stomach cancer-related mortality rates were the highest among individuals born between 1885 and 1895.

An investigation of the historical background of stomach cancer showed that in the late 1960s, stomach cancer-related mortality rates in Japan shifted from an increasing to a decreasing trend, but that this shift occurred at different times for different age groups [7]. Among the elderly, the time of the shift was later compared with younger age groups. In 1970, at the beginning of the present study, stomach cancer-related mortality rates among young age groups had already begun to decrease, whereas among older age groups they were still increasing. In addition, because there is no upper age limit in the group aged >85 years, as time goes on, the elderly population with high mortality rates will remain in this single age category, contributing to its rising mortality rates. The status of this age group, therefore, becomes more complex with the rapidly increasing life expectancy in Japan.

Clearly, increasing stomach cancer-related mortality rates within the >85-year-old group are temporary. When this generation of individuals has died, a decreasing trend will be apparent [21], despite the variation with regard to time among different age groups. In fact, from the year 2000, stomach cancer-related mortality rates have already decreased for the >85-year-old group, and a recent trend analysis further supports this observation. As a result of the rapid increase in life expectancy in Japan, it has been possible in recent years to further differentiate the >85-year-old group into two subgroups: 85–89 years old and >90 years old. Stomach cancer-related mortality rates then become clearly divided: over 650 per 100,000 in the >90-year-old group and 300 per 100,000 individuals in the 85–89-year-old group; the latter group (85–89 years old) is substantially lower. Through the end of period studied, the oldest generations (>90 years old) maintained high mortality rates, but among the 85–90 years groups, as with younger age groups, a substantial decrease was observed in both genders.

Although we did not find any factors directly correlated with high stomach cancer-related mortality rates in this generation, trends in mortality might have been influenced by changes in risk factors, such as diet pattern and economic level. For example, it is reported that fiber content declined in the Japanese diet, probably beginning in the late 19th century [13]: 'Between 1885 and 1910 occurred a rapidly increased birth rate with lower nutrition from infant to adult, hard work and poor living conditions. Large raise-up of wages for factory workers around 1920 and increase trend in income for other workers by economic growth since 1900 had been improved not only working and living conditions, but also dietary life...'. Aoki has also reported that an acute increase in tuberculosis occurred during that period of time [1].

Overall, this variation of mortality distribution in the specific age population is due to being in the change period of the general mortality pattern.

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