JJCO Japanese Journal of Clinical Oncology

Jpn J Clin Oncol 2013;43(5)492–507
doi:10.1093/jjco/hyt038
Advance Access Publication 14 March 2013

An Updated Report of the Trends in Cancer Incidence and Mortality in Japan

Kota Katanoda[1,*], Tomohiro Matsuda[1], Ayako Matsuda[1], Akiko Shibata[1], Yoshikazu Nishino[2], Manabu Fujita[3], Midori Soda[4], Akiko Ioka[5], Tomotaka Sobue[6] and Hiroshi Nishimoto[1]

[1]Cancer Information Services and Surveillance Division, Center for Cancer Control and Information Services, National Cancer Center, Tokyo, [2]Division of Cancer Epidemiology and Prevention, Miyagi Cancer Center Research Institute, Natori, Miyagi, [3]Department of Internal Medicine, Fukui Social Insurance Hospital, Katsuyama, Fukui, [4]Department of Epidemiology, Radiation Effects Research Foundation, Nagasaki, [5]Center for Cancer Control and Statistics, Osaka Medical Center for Cancer and Cardiovascular Diseases and [6]Division of Environmental Medicine and Population Sciences, Department of Social and Environmental Medicine, Graduate School of Medicine, Osaka University, Osaka, Japan

*For reprints and all correspondence: Kota Katanoda, Cancer Information Services and Surveillance Division, Center for Cancer Control and Information Services, National Cancer Center, 5-1-1 Tsukiji Chuo-ku, Tokyo 104-0045, Japan. E-mail: kkatanod@ncc.go.jp

Received November 16, 2012; accepted February 19, 2013

Objective: The analysis of cancer trends in Japan has only been sporadically reported. We present a comprehensive report on the trends in cancer incidence and mortality in Japan using the most recent population-based data.
Methods: National cancer mortality data between 1958 and 2011 were obtained from published vital statistics. Cancer incidence data between 1985 and 2007 were obtained from high-quality population-based cancer registries of four prefectures (Miyagi, Yamagata, Fukui and Nagasaki). Joinpoint regression analysis was performed to examine the trends in age-standardized rates of cancer incidence and mortality.
Results: All-cancer mortality decreased from the mid-1990s, with an annual percent change of −1.3% (95% confidence interval: −1.4, −1.3), while all-cancer incidence continually increased from 1985, with an annual percent change of 0.7% (95% confidence interval: 0.6, 0.8). Major cancer sites, particularly the liver, colorectum and lung (males), showed a pattern of increasing incidence and mortality rates until the mid-1990s, stabilizing or decreasing thereafter. Stomach cancer showed a long-term decreasing trend for both incidence and mortality, while female breast cancer showed a continuously increasing trend. The incidence of prostate cancer, particularly at the localized stage, increased rapidly between 2000 and 2003, while that of mortality decreased from 2004. No changes were detected in the incidence or mortality for colorectal, female breast or cervical cancers after the establishment of national screening programs for these cancers.
Conclusions: The analysis of cancer trends in Japan revealed a recent decrease in mortality and a continuous increase in incidence, which are considered to reflect changes in the underlying risk factors such as tobacco smoking and infection, and are partially explained by early detection and improved treatment.

Key words: cancer – incidence – mortality – neoplasms – population surveillance

INTRODUCTION

National estimates of cancer incidence in Japan are annually reported as an Epidemiology Note in the Japanese Journal of Clinical Oncology (1,2). These data are useful for monitoring the most recent status of cancer incidence in Japan; however, analytical approaches, such as trend and clinical-stage distribution analyses, have yet to be performed using the data. Although a trend analysis of cancer mortality in Japan was reported, the data were outdated, as 2004 was the most recent year examined (3).

Recently, we developed and validated a method for the trend analysis of national cancer incidence using data from four prefectural cancer registries in Japan (4). However, trend analysis of current cancer registry data using this method is needed to identify cancers with increasing or decreasing rates. In the USA, the American Cancer Society publishes an annual report on trends in cancer incidence and mortality based on the analysis of up-to-date data (5). Here we present an updated report on the trends in cancer incidence and mortality in Japan and propose that this approach should serve as a model for future annual reports on the analysis of cancer trends in Japan.

METHODS

Cancer Mortality

The target population for determining cancer mortality was the entire Japanese population. We obtained the number of annual cancer deaths between 1958 and 2011 from published vital statistics (6). We analyzed site-specific cancers and all cancers combined with reference to the International Classification of Diseases (ICD) version 10 codes. Population data for the calculation of mortality rates were also obtained from published vital statistics.

Cancer Incidence

The target population for determining cancer incidence was that of the Japanese prefectures Miyagi, Yamagata, Fukui and Nagasaki, which were selected because long-term, high-quality data from population-based cancer registries were available between 1985 and 2007. The population coverage of the four prefectures from 1985 to 2007 averaged 4.7%. It was previously confirmed that the trends in mortality for major cancer sites in these prefectural populations were representative of national trends (4). The previous study showed that the data quality of the four cancer registries was chronologically stable for the period between 1985 and 2004. Although we added data for recent 3 years in the present study, the quality indexes stayed stable (Fig. 1); the proportions of death certificate notification, death certificate only and microscopically verified cases were 14.5, 9.1 and 79.1%, respectively, for the period between 1985 and 2004 and 14.2, 9.4 and 78.8%, respectively, for the period between 1985 and 2007.

Data collection was conducted in 2010 for cancers diagnosed between 1985 and 1992, and in 2011 for cancers diagnosed between 1993 and 2007. Details of data collection and quality assessment were described in a previous study (4). We analyzed site-specific cancers and all cancers combined with reference to the ICD-10 codes converted from ICD for Oncology version 2 or 3. Carcinoma *in situ* (CIS) was generally excluded from the tabulation of cancer incidence, although cases including CIS were analyzed for several cancer sites (esophagus, colorectum, lung, skin, breast (female), uterus and bladder). Population data were obtained from the

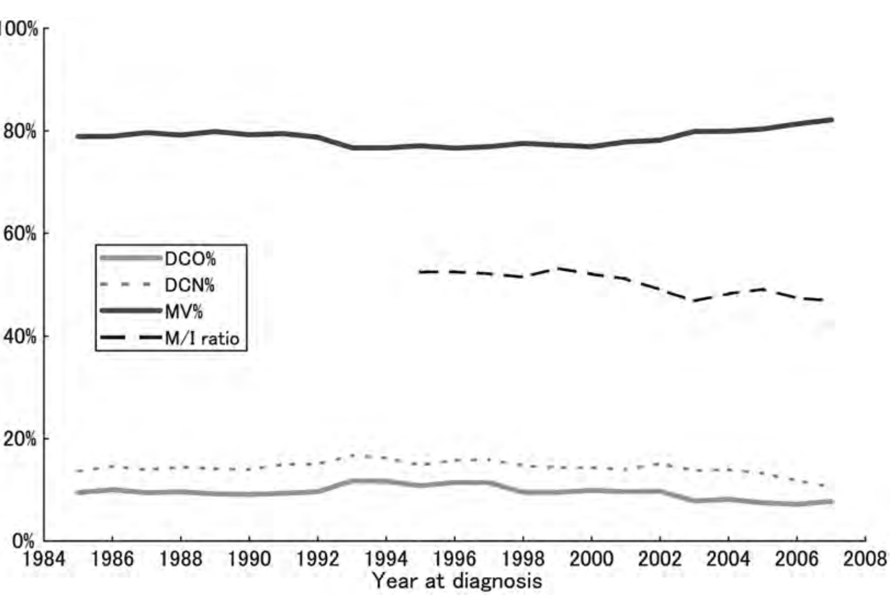

Figure 1. Trends in the quality indexes of cancer incidence data from four prefectures: Miyagi, Yamagata, Fukui and Nagasaki prefectures. DCO, death certificate only; DCN, death certificate notification; MV, microscopically verified; M/I, mortality to incidence.

website managed by the Surveillance Division, Center for Cancer Control and Information Services, National Cancer Center, Japan (7).

Statistical Analysis

Annual age-standardized rates (ASRs; standardized to the 1985 model Japanese population) for cancer mortality and cancer incidence were calculated using data of the entire Japanese population and the four prefectures, respectively. We used a Joinpoint regression model (8) implemented in the Joinpoint Regression Program (Version 3.4.3) developed by the US National Cancer Institute. The Joinpoint method identifies changes in data trends by connecting several different line segments on a log scale at 'joinpoints'. The annual percent change (APC) and the corresponding 95% confidence interval (CI) were estimated for each line segment. In our Joinpoint analysis, the number of incidence or deaths was assumed to follow a Poisson distribution. The maximum number of joinpoints, minimum number of observations from a joinpoint to either end of the data and minimum number of observations between two joinpoints were set at four, three and four, respectively (default settings).

To identify the major sites of cancer contributing to the recent decrease in all-cancer mortality detected in the Joinpoint regression analysis, we calculated the degree of contribution for individual cancer sites as follows. First, we identified the 'last segment', which was defined as the period starting from the last joinpoint to the end of observation period (i.e. 2011), for the trend of all-cancer mortality. Secondly, we used a log-linear regression model to site-specific cancer mortality rates during the 'last segment' and identified cancer sites that significantly decreased during this period. Thirdly for each cancer site exhibiting a significant decrease in mortality, we calculated the difference in the mortality rate between the first and last years of the 'last segment'. Finally, we summed the difference and calculated the proportion of each cancer site relative to the total difference. These steps were performed for the ASRs of mortality by sex.

RESULTS

Table 1 shows the results of Joinpoint regression analysis on the trends in all-cancer mortality rates in Japan between 1958 and 2007. The combined ASRs of all-cancer mortality for males and females increased from the beginning of the observation period until the mid-1960s, decreased in the subsequent three decades, temporarily became stable in the mid-1990s and decreased again from 1996 through the end of the observation period. The most recent APC in the ASR was −1.3% for the period between 1996 and 2011. The sex-specific ASRs also decreased from 1996, with APCs of −1.6 and −1.1% for males and females, respectively. These patterns were similar for those <75 years of age, showing APCs with slightly steeper decreases than those of all ages. Nearly 80% of the decrease in all-cancer mortality among males observed from 1996 was accounted for by a decrease in mortality rates for stomach, liver and lung cancers (37.4, 28.3 and 14.1%, respectively). For females, 72% of the decrease in all-cancer mortality from 1996 was due to a decrease in mortality rates for stomach, liver and gallbladder cancers (41.4, 16.9 and 14.0%, respectively). Colorectal cancer accounted for ~10% of the decrease in all-cancer mortality for both males and females (7.2 and 11.4%, respectively).

Tables 2 and 3 show the site-specific results of Joinpoint regression analysis of cancer mortality for males and females, respectively. Figure 2 shows the trends in ASRs of mortality for major cancer sites. The mortality rate of stomach cancer continuously decreased during the observation period for both males and females, with APCs of −3.2 and −3.8%, respectively, for the most recent period. Many of the major cancer sites, including the colorectum and liver for both males and females, and the lung and prostate for males, had a similar pattern of increasing mortality rates until the mid-1990s, at which point the ASRs stabilized or decreased. Notably, the ASRs of female breast cancer continuously increased from the mid-1960s to the end of observation period, with the most recent APC estimated to be 1.2%. The ASRs of uterine cancer rapidly decreased until the mid-1990s and continued to decrease slowly until 2009. However, the mortality rates of cancer of the cervix uteri and corpus began to increase from around 1990 and 1970, respectively. Among the other examined cancer sites, the following sites showed recent significant increases in the ASR of mortality, with APCs >1%: male brain and nervous system, and female pancreas and urinary organs other than the bladder.

Table 4 shows the results of Joinpoint regression analysis on the trends in all-cancer incidence in the four selected prefectures in Japan. For both males and females, irrespective of the inclusion of those aged 75 years or older, the ASRs of all-cancer incidence continuously increased during the entire observation period (1985–2007), with APCs <1%. When we included CIS, the APC values increased slightly.

Tables 5 and 6 show the cancer site-specific results of Joinpoint regression analysis of cancer incidence for males and females, respectively, in the four prefectures. Figure 3 shows the trends in ASRs of incidence for major cancer sites. The incidence rate of stomach cancer continuously decreased from the beginning of the observation period (1985), with APCs of −1.7 and −2.5% for males and females, respectively. Among females, the incidence rate continued to decrease until the end of the observation period (2007), whereas that among males decreased until 2005. The typical pattern observed for trends in mortality, namely, an increase until the mid-1990s followed by stable or decreasing rates thereafter, was also seen for the incidence of colorectum and liver cancers for males and females, and for lung cancer among males. The incidence rate of prostate cancer increased until 2000 with an APC of 5.1%, markedly jumped between 2000 and 2003 with an APC of 29.7% and then became stable. The incidence rate of female breast

Table 1. Results of Joinpoint regression analysis on the trends in all-cancer mortality (1958–2011)

Cancer site	ICD-10	Age	Sex	Number of joinpoints	Line segment		Annual % change	95% confidence interval		
					Start	End		Lower	Upper	
All cancers	C00–C97	All ages	Males and females	3	1958	1966	0.5	0.1	0.8	*
					1966	1993	−0.2	−0.2	−0.1	*
					1993	1996	1.1	−0.6	2.9	
					1996	2011	−1.3	−1.4	−1.3	*
			Males	3	1958	1987	0.5	0.5	0.6	*
					1987	1993	−0.2	−0.7	0.3	
					1993	1996	1.9	−0.3	4.1	
					1996	2011	−1.6	−1.6	−1.5	*
			Females	3	1958	1968	−0.1	−0.3	0.1	
					1968	1993	−0.8	−0.9	−0.8	*
					1993	1996	0.8	−1.0	2.6	
					1996	2011	−1.1	−1.2	−1.1	*
		<75 years old	Males and females	4	1958	1967	0.0	−0.3	0.2	
					1967	1975	−1.1	−1.3	−0.8	*
					1975	1993	−0.7	−0.8	−0.6	*
					1993	1996	1.4	−0.3	3.0	
					1996	2011	−1.9	−1.9	−1.8	*
			Males	2	1958	1964	0.4	−0.2	1.1	
					1964	1998	−0.2	−0.2	−0.2	*
					1998	2011	−2.3	−2.5	−2.2	*
			Females	3	1958	1968	−0.6	−0.8	−0.4	*
					1968	1991	−1.5	−1.6	−1.4	*
					1991	1997	−0.2	−0.7	0.3	
					1997	2011	−1.3	−1.4	−1.2	*

*Annual % change is statistically significantly different from zero.

cancer, as was observed for mortality, continuously increased during the observation period, reaching an APC of 4.4% in the most recent period. The incidence rate of uterine cancer also increased from the mid-1990s, with an APC of 2.4%. Cervical cancer had a similar pattern, although the most recent increase was not significant. Cancer of the corpus uteri rapidly increased in incidence from 2004 with an APC of 13.7%. Among other cancer sites, the following showed recent increases with APCs >1%: oral cavity and pharynx, skin, ovary, kidney and urinary organs (excluding bladder), thyroid and malignant lymphoma.

Figure 4 shows the trends in the proportion of cancers at the localized stage for major cancer sites. For all cancers combined, the proportion of localized cancers increased during the observation period, from 44% in 1993 to 52% in 2007. Colorectal cancer displayed a similar trend in the proportion of localized cancers, as was observed for all cancers combined. When CIS in the colorectum was included, the trend remained unchanged, although the absolute proportion of localized cancers increased by ~10%. For stomach and female breast cancers, the proportion of localized cancers increased from ~55% in 1993 to 60% or higher in 2007. When CIS for female breast cancer was included, the absolute percentage increased by 2–4%. For lung cancer, the proportion of localized cancers seemed to increase during the observation period, but remained as low as 33%. For cervical cancer, the proportion of localized cancers remained stable at ~50 and at 80% when CIS was included. For prostate cancer, the proportion of localized cancers rapidly increased, between 1997 and 2003, from 40 to 60% or higher.

DISCUSSION

We analyzed the trends in cancer incidence and mortality in Japan between 1958 and 2011 and between 1985 and 2007,

Table 2. Results of Joinpoint regression analysis on the trends in cancer mortality by site (1958–2011), for males

Cancer site	ICD-10	Number of joinpoints	Line segment		Annual % change	95% confidence interval		
			Start	End		Lower	Upper	
Oral cavity and pharynx	C00–C14	2	1958	1993	1.9	1.7	2.0	*
			1993	1996	9.7	2.7	17.3	*
			1996	2011	0.2	0.0	0.5	
Esophagus	C15	3	1958	1970	1.3	0.9	1.8	*
			1970	1984	−1.1	−1.4	−0.8	*
			1984	2001	0.5	0.3	0.7	*
			2001	2011	−1.5	−1.8	−1.2	*
Stomach	C16	4	1958	1969	−0.5	−0.7	−0.3	*
			1969	1980	−2.6	−2.9	−2.3	*
			1980	1993	−3.2	−3.4	−3.1	*
			1993	1996	−0.8	−4.1	2.5	
			1996	2011	−3.2	−3.3	−3.1	*
Colon	C18	3	1958	1985	4.7	4.6	4.9	*
			1985	1996	3.0	2.7	3.2	*
			1996	2009	−1.3	−1.4	−1.2	*
			2009	2011	0.6	−1.7	2.9	
Rectum	C19–C20	2	1958	1974	2.3	1.9	2.7	*
			1974	1998	0.5	0.4	0.6	*
			1998	2011	−1.1	−1.4	−0.9	*
Liver	C22	4	1958	1974	−0.6	−0.9	−0.3	*
			1974	1986	4.2	3.9	4.6	*
			1986	1996	1.0	0.6	1.3	*
			1996	2002	−2.3	−3.1	−1.6	*
			2002	2011	−4.3	−4.6	−4.0	*
Gallbladder and bile ducts	C23–C24	3	1958	1965	10.1	8.3	12.0	*
			1965	1987	4.4	4.2	4.6	*
			1987	1995	0.4	−0.1	1.0	
			1995	2011	−1.6	−1.7	−1.4	*
Pancreas	C25	3	1958	1968	7.3	6.4	8.2	*
			1968	1987	3.1	2.9	3.3	*
			1987	2003	0.1	−0.1	0.2	
			2003	2011	0.6	0.3	1.0	*
Larynx	C32	3	1958	1972	0.3	−0.2	0.8	
			1972	1991	−3.2	−3.5	−2.9	*
			1991	1997	0.6	−1.5	2.6	
			1997	2011	−3.8	−4.2	−3.4	*
Lung, trachea	C33–C34	4	1958	1963	7.5	5.9	9.2	*
			1963	1981	4.6	4.4	4.8	*
			1981	1989	2.2	1.9	2.6	*
			1989	1996	1.0	0.6	1.4	*
			1996	2011	−0.9	−0.9	−0.8	*

Continued

Table 2. *Continued*

Cancer site	ICD-10	Number of joinpoints	Line segment		Annual % change	95% confidence interval		
			Start	End		Lower	Upper	
Skin	C43−C44	3	1958	1977	−1.4	−1.9	−0.9	*
			1977	1980	−10.4	−24.0	5.7	
			1980	1991	−2.5	−3.8	−1.3	*
			1991	2011	0.2	−0.2	0.6	
Prostate	C61	3	1958	1993	3.2	3.1	3.4	*
			1993	1996	7.2	1.3	13.4	*
			1996	2004	0.4	−0.3	1.0	
			2004	2011	−1.4	−2.0	−0.9	*
Bladder	C67	3	1958	1980	1.2	0.9	1.5	*
			1980	1988	−1.6	−2.9	−0.3	*
			1988	1999	1.2	0.6	1.9	*
			1999	2011	−0.5	−0.9	−0.2	*
Kidney and other urinary organs	C64−C66 C68	3	1958	1977	4.1	3.7	4.5	*
			1977	1984	6.0	4.5	7.5	*
			1984	1996	2.3	1.9	2.8	*
			1996	2011	0.8	0.6	1.0	*
Brain, nervous system	C70−C72	4	1958	1970	1.3	−0.3	2.9	
			1970	1980	5.7	3.9	7.6	*
			1980	1997	1.6	1.1	2.1	*
			1997	2007	−0.7	−1.8	0.5	
			2007	2011	5.1	1.3	9.0	*
Thyroid	C73	2	1958	1966	6.9	2.9	11.0	*
			1966	1987	0.9	0.2	1.5	*
			1987	2011	−0.3	−0.6	0.1	
Malignant lymphoma	C81−C85 C96	4	1958	1967	4.0	2.9	5.0	*
			1967	1980	2.4	2.0	2.9	*
			1980	2001	0.7	0.6	0.9	*
			2001	2005	−2.7	−4.9	−0.4	*
			2005	2011	−0.2	−0.9	0.6	
Multiple myeloma	C88−C90	3	1958	1968	12.7	10.1	15.4	*
			1968	1980	6.4	5.2	7.6	*
			1980	2000	1.7	1.4	2.0	*
			2000	2011	−1.7	−2.2	−1.2	*
Leukemia	C91−C95	2	1958	1976	2.4	2.1	2.6	*
			1976	1987	1.2	0.8	1.7	*
			1987	2011	−0.8	−0.9	−0.7	*
Colon/rectum	C18−C20	2	1958	1980	3.1	2.9	3.3	*
			1980	1996	2.1	1.9	2.3	*
			1996	2011	−1.1	−1.2	−1.0	*

*Annual % change is statistically significantly different from zero.

Table 3. Results of Joinpoint regression analysis on the trends in cancer mortality by site (1958–2011), for females

Cancer site	ICD-10	Number of joinpoints	Line segment		Annual % change	95% confidence interval		
			Start	End		Lower	Upper	
Oral cavity and pharynx	C00–C14	3	1958	1979	0.7	0.3	1.1	*
			1979	1990	−1.1	−2.0	−0.2	*
			1990	1998	4.6	3.2	6.0	*
			1998	2011	−0.4	−0.8	0.0	
Esophagus	C15	2	1958	1969	−0.1	−0.7	0.5	
			1969	1988	−3.9	−4.2	−3.7	*
			1988	2011	−0.9	−1.1	−0.8	*
Stomach	C16	4	1958	1970	−0.8	−0.9	−0.6	*
			1970	1979	−3.2	−3.5	−2.9	*
			1979	1993	−4.3	−4.5	−4.2	*
			1993	1996	−2.5	−5.5	0.5	
			1996	2011	−3.8	−4.0	−3.7	*
Colon	C18	4	1958	1982	3.4	3.2	3.5	*
			1982	1993	2.3	2.0	2.6	*
			1993	2004	−0.4	−0.7	−0.2	*
			2004	2008	−2.3	−3.7	−0.8	*
			2008	2011	0.2	−1.2	1.7	
Rectum	C19–C20	2	1958	1974	1.3	1.0	1.6	*
			1974	2007	−1.3	−1.4	−1.2	*
			2007	2011	−2.4	−4.1	−0.7	*
Liver	C22	4	1958	1975	−2.4	−2.6	−2.2	*
			1975	1993	0.3	0.1	0.5	*
			1993	1996	3.6	−0.2	7.6	
			1996	2001	−0.7	−1.8	0.4	
			2001	2011	−3.6	−3.9	−3.3	*
Gallbladder and bile ducts	C23–C24	4	1958	1963	12.0	8.9	15.2	*
			1963	1972	6.1	5.1	7.0	*
			1972	1985	4.1	3.7	4.4	*
			1985	1992	0.0	−0.6	0.7	
			1992	2011	−3.0	−3.1	−2.9	*
Pancreas	C25	4	1958	1967	6.4	5.5	7.3	*
			1967	1988	2.8	2.7	3.0	*
			1988	1994	−0.4	−1.2	0.4	
			1994	2006	0.6	0.4	0.8	*
			2006	2011	2.3	1.6	2.9	*
Larynx	C32	2	1958	1976	−4.3	−5.0	−3.5	*
			1976	1986	−8.9	−11.3	−6.4	*
			1986	2011	−3.6	−4.3	−3.0	*

Continued

Table 3. *Continued*

Cancer site	ICD-10	Number of joinpoints	Line segment		Annual % change	95% confidence interval		
			Start	End		Lower	Upper	
Lung, trachea	C33–C34	4	1958	1963	6.5	4.4	8.7	*
			1963	1984	3.1	2.9	3.3	*
			1984	1998	0.9	0.7	1.1	*
			1998	2003	−1.9	−2.9	−0.9	*
			2003	2011	0.0	−0.4	0.3	
Skin	C43–C44	2	1958	1975	−2.0	−2.7	−1.2	*
			1975	1986	−6.2	−7.8	−4.5	*
			1986	2011	0.6	0.1	1.0	*
Breast	C50	4	1958	1964	−0.5	−2.0	1.0	
			1964	1978	2.3	2.0	2.7	*
			1978	1990	1.4	1.1	1.8	*
			1990	1997	3.3	2.5	4.1	*
			1997	2011	1.2	1.0	1.4	*
Uterus	C53–C55	4	1958	1972	−3.2	−3.4	−3.1	*
			1972	1987	−5.0	−5.2	−4.9	*
			1987	1993	−3.4	−4.3	−2.4	*
			1993	2009	−0.3	−0.5	−0.1	*
			2009	2011	3.4	−0.9	8.0	
Cervix uteri	C53	4	1958	1965	−1.9	−3.3	−0.5	*
			1965	1973	−5.2	−6.5	−3.7	*
			1973	1978	1.1	−2.4	4.7	
			1978	1989	−2.4	−3.2	−1.6	*
			1989	2011	0.5	0.2	0.7	*
Corpus uteri	C54	3	1958	1966	−6.2	−8.2	−4.2	*
			1966	1972	−14.2	−19.2	−8.9	*
			1972	1999	4.2	3.8	4.6	*
			1999	2011	2.5	1.8	3.2	*
Ovary	C56	4	1958	1981	3.8	3.6	4.0	*
			1981	1988	1.8	0.8	2.9	*
			1988	1997	0.8	0.2	1.4	*
			1997	2000	−3.1	−7.8	1.9	
			2000	2011	−0.2	−0.5	0.2	
Bladder	C67	2	1958	1971	1.1	0.3	1.9	*
			1971	1988	−1.9	−2.4	−1.4	*
			1988	2011	−0.3	−0.5	−0.1	*
Kidney and other urinary organs	C64–C66 C68	2	1958	1976	1.5	0.8	2.1	*
			1976	1986	4.0	2.7	5.3	*
			1986	2011	1.3	1.1	1.5	*
Brain, nervous system	C70–C72	2	1958	1969	1.2	−1.5	4.1	
			1969	1980	6.1	3.7	8.5	*
			1980	2011	0.9	0.6	1.2	*

Continued

Table 3. *Continued*

Cancer site	ICD-10	Number of joinpoints	Line segment		Annual % change	95% confidence interval		
			Start	End		Lower	Upper	
Thyroid	C73	2	1958	1977	1.9	1.5	2.4	*
			1977	2005	−1.0	−1.2	−0.9	*
			2005	2011	−2.5	−3.8	−1.1	*
Malignant lymphoma	C81−C85 C96	3	1958	1981	2.5	2.3	2.8	*
			1981	2002	0.9	0.7	1.0	*
			2002	2006	−3.2	−5.8	−0.6	*
			2006	2011	0.7	−0.5	1.8	
Multiple myeloma	C88−C90	4	1958	1968	14.8	12.3	17.4	*
			1968	1983	5.6	5.0	6.3	*
			1983	1999	1.3	1.0	1.7	*
			1999	2007	−0.7	−1.5	0.1	
			2007	2011	−3.7	−5.6	−1.8	*
Leukemia	C91−C95	3	1958	1964	4.0	2.6	5.5	*
			1964	1984	0.9	0.7	1.0	*
			1984	1998	−1.1	−1.3	−0.8	*
			1998	2011	−1.8	−2.0	−1.5	*
Colon/rectum	C18−C20	3	1958	1974	2.3	2.1	2.6	*
			1974	1992	1.1	1.0	1.3	*
			1992	2004	−0.5	−0.7	−0.3	*
			2004	2009	−2.1	−3.0	−1.2	*

*Annual % change is statistically significantly different from zero.

respectively, and found that all-cancer mortality began to decrease from the mid-1990s, whereas all-cancer incidence continues to increase from 1985. Among major cancers, liver cancer contributed to the decrease in cancer mortality from the mid-1990s. The incidence of liver cancer was also characterized by a decrease beginning in the 1990s. In Japan, hepatocellular carcinoma (HCC) accounts for 90% of liver cancer cases. Approximately 76% of HCC is caused by chronic infection with hepatitis C virus (HCV) (9). The positive rate of HCV infection has been rapidly decreasing in the generation born after the early 1930s (10). Therefore, the decrease in liver cancer incidence and mortality observed in the present study can be interpreted as a result of the decreasing trend in HCV infection (11). The positive rate of hepatitis B virus infection has also been decreasing after the generation born in 1940s. This might have accelerated the decrease in liver cancer incidence and mortality. However, the influence of HBV is considered to be small, because HBV accounts for only 17% of HCC in Japan, and the peak positive rate of HBV is much lower than that of HCV (9). Regarding prognosis, the population-based survival rates of liver cancer patients increased statistically significantly between the periods of 1993−1996 and 2000−2002, which was interpreted as a result of improved diagnostic and therapeutic strategy for HCC (12,13). The decrease in liver cancer mortality from the late 1990s may have included this effect.

Male lung cancer reached a peak in the mid-1990s for both incidence and mortality. As ∼70% of male lung cancer is reportedly due to active tobacco smoking (14), the observed peaks in lung cancer incidence and mortality may be a result of the high smoking prevalence in the 1960s or the peak in per capita cigarette consumption in the 1970s (15). Organized screening programs for lung cancer using chest X-rays and sputum cytology were initiated nationwide in Japan in 1987 (16). A clinical study indicated that the prognosis of lung cancer patients improved between 1989 and 1999, which was interpreted as a combined effect of increased proportion and improved treatment of early stage cases (17). A population-based study also showed a consistent result (12). In the present study, the proportion of localized stage of lung cancer has been slowly increasing after 1993 (Fig. 4), and a decrease in lung cancer mortality was observed after 1996 for males and between 1998 and 2003 for females (Tables 2 and 3, respectively). These changes may have partially reflected the early detection and improved treatment.

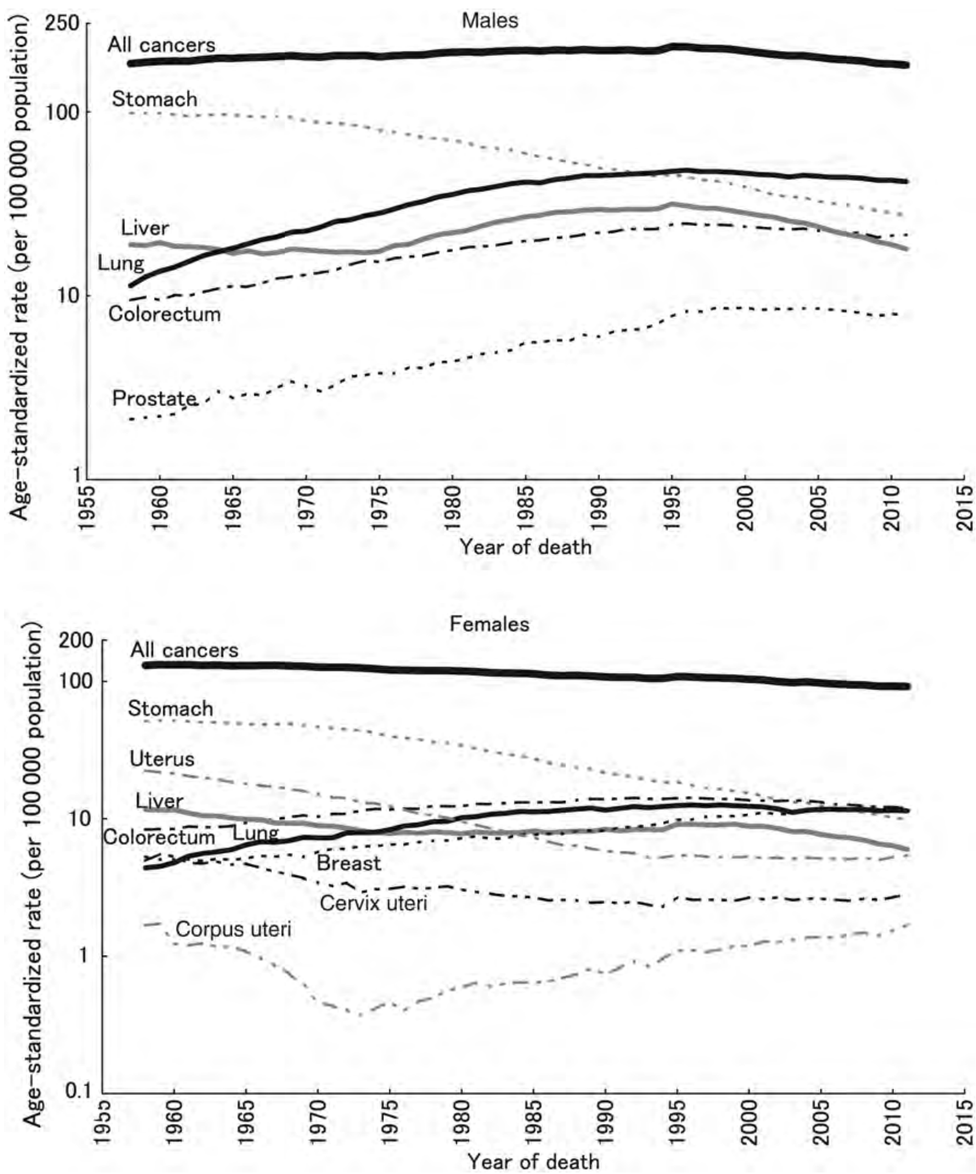

Figure 2. Trends in the ASR of all-cancer and site-specific cancer mortality.

Colorectal cancer also reached a peak in the mid-1990s for both incidence and mortality, indicating an association with preventive/risk factors. Although alcohol consumption, overweight/obesity and low physical activity are probable or established risk factors for colorectal cancer in Japan (18), it is difficult to determine which of these factors dominantly influenced the trends in colorectal cancer, because the population attributable fraction of these factors is not as large as HCV infection for liver cancer or tobacco smoking for male lung cancer (19). Organized screening programs for colorectal cancer based on the fecal occult blood test was started nationwide in Japan in 1992 (16). Colorectal cancer incidence stopped increasing shortly after this year (in 1995 and 1996 for males and females, respectively), which might be interpreted as a result of early detection and resection of adenoma. However, a similar trend was observed for colorectal cancer including CIS, and no changes were observed around this period in the proportion of localized stage or CIS in colorectal cancer. Regarding prognosis, the survival rates of colorectal cancer did not change statistically significantly between the periods of 1993–1996 and 2000–2002 (12).

Stomach cancer accounted for ~40% of the decrease of all-cancer mortality from the mid-1990s. However, a decrease in both the incidence and mortality of stomach cancer was observed from the beginning of the observation period. This long-term decrease in stomach cancer incidence and mortality is likely due to a decrease in *Helicobacter pylori* infection for those born after 1950 (20). Although decreased salt intake may also be a reason for the decline in stomach cancer incidence and mortality, its contribution is considered to be relatively small (19). The accelerated decrease in stomach

Table 4. Results of Joinpoint regression analysis on the trends in all-cancer incidence (1985–2007)[a]

Cancer site	ICD-10	Age	Sex	Number of joinpoints	Line segment		Annual % change	95% confidence interval		
					Start	End		Lower	Upper	
All cancers	C00–C96	All ages	Males and females	0	1985	2007	0.7	0.6	0.8	*
			Males	0	1985	2007	0.6	0.5	0.8	*
			Females	0	1985	2007	0.8	0.7	0.9	*
		<75 years old	Males and females	0	1985	2007	0.6	0.5	0.8	*
			Males	0	1985	2007	0.3	0.1	0.5	*
			Females	0	1985	2007	0.9	0.8	1.0	*
All cancers (including cis)	C00–C96; D00–D09	All ages	Males and females	0	1985	2007	1.1	1.0	1.2	*
			Males	1	1985	1991	1.9	0.6	3.1	*
					1991	2007	0.7	0.5	1.0	*
			Females	0	1985	2007	1.3	1.1	1.4	*
		<75 years old	Males and females	0	1985	2007	1.1	0.9	1.2	*
			Males	1	1985	1991	1.8	0.4	3.3	*
					1991	2007	0.4	0.1	0.7	*
			Females	1	1985	2001	1.2	1.0	1.4	*
					2001	2007	2.3	1.5	3.1	*

[a]Miyagi, Yamagata, Fukui and Nagasaki prefectures.
*Annual % change is statistically significantly different from zero.

cancer mortality beginning around 1970 is reportedly a result of improved treatment strategies in combination with early detection by organized X-ray screening programs that were started nationwide in 1983 (16,21).

Female breast cancer showed no sign of decline for either incidence or mortality. Preventive/risk factors, such as longer exposure to endogenous sex hormones, overweight/obesity and lower physical activity (18), might have affected the increase in female breast cancer, although it remains unknown which factors are dominant. Organized screening programs for female breast cancer by clinical breast examination (CBE) started in 1987 in Japan, and mammography in combination with CBE has been adopted since 2000 (target ages were expanded from 50+ years old to 40+ years old in 2004) (16). However, no changes in female breast cancer incidence or proportion of localized cancers were observed in the year following the initiation of these programs. According to the Comprehensive Survey of Living Conditions, a Japanese national survey based on self-administered questionnaires, the breast cancer screening rate among females aged 40 years or older has been around 20% (19.8% in 2004, 20.3% in 2007 and 24.3% in 2010) (22). Regarding prognosis, the population-based survival rate of female breast cancer statistically significantly improved between the periods of 1997–1999 and 2000–2002, which was interpreted as an improvement of treatment (12). However, no decreases in mortality were observed during the same period in the present study.

The finding that the mortality of cervix and corpus uteri cancers began to increase around 1990 and 1970, respectively, should be interpreted with caution, because the proportion of cancer of the ‘uterus, not otherwise specified (NOS)’ has been continuously increasing in Japan. In spite of the decrease in cancer of the ‘uterus, NOS’, cervical cancer mortality showed long-term decreases starting between the late 1950s and late 1980s. In addition, the incidence of cervical cancer also decreased until late 1990s, a finding that may have resulted from improved hygiene. It is notable that the mortality of cervical cancer began to increase in 1989, particularly among women aged between 35 and 59 years, and that the incidence of cervical cancer stopped decreasing in the late 1990s. Organized screening programs for cervical cancer using pap smears were started nationwide in Japan in 1983 (16). Though the incidence of cervical cancer including CIS continuously increased after 1985, both the incidence and mortality of invasive cervical cancer stopped decreasing in 1989 and 1997, respectively. Moreover, there were no notable changes in the proportion of localized stage or CIS in cervical cancer between 1993 and 2007. According to the Comprehensive Survey of Living Conditions, the cervical cancer screening rate has been around 20% (20.8% in 2004, 21.3% in 2007 and 24.3% in 2010 for females aged 20 years

Table 5. Results of Joinpoint regression analysis on the trends in cancer incidence by site (1985–2007), for males[a]

Cancer site	ICD-10	Number of joinpoints	Line segment		Annual % change	95% confidence interval		
			Start	End		Lower	Upper	
Oral cavity and pharynx	C00–C14	0	1985	2007	2.2	1.7	2.7	*
Esophagus	C15	0	1985	2007	0.9	0.5	1.3	*
Stomach	C16	1	1985	2005	−1.7	−1.9	−1.5	*
			2005	2007	1.4	−5.6	8.9	
Colon	C18	1	1985	1995	5.5	4.6	6.5	*
			1995	2007	−0.4	−1.0	0.1	
Rectum	C19–C20	1	1985	1995	3.8	2.8	4.9	*
			1995	2007	−0.2	−0.8	0.4	
Liver	C22	1	1985	1995	1.9	0.9	2.9	*
			1995	2007	−2.7	−3.3	−2.1	*
Gallbladder and bile ducts	C23–C24	1	1985	1995	1.2	−0.4	2.8	
			1995	2007	−1.6	−2.6	−0.6	*
Pancreas	C25	0	1985	2007	0.2	−0.1	0.5	
Larynx	C32	0	1985	2007	−0.6	−1.3	0.1	
Lung, trachea	C33–C34	1	1985	1996	1.5	1.1	1.8	*
			1996	2007	−0.1	−0.4	0.1	
Skin	C43−C44	0	1985	2007	2.3	1.6	2.9	*
Prostate	C61	2	1985	2000	5.1	4.2	6.1	*
			2000	2003	29.7	13.3	48.6	*
			2003	2007	−0.6	−3.8	2.7	
Bladder	C67	1	1985	2003	0.7	0.3	1.2	*
			2003	2007	−4.5	−8.2	−0.6	*
Kidney and other urinary organs	C64–C66 C68	0	1985	2007	2.8	2.3	3.3	*
Brain, nervous system	C70–C72	0	1985	2007	−0.4	−1.0	0.3	
Thyroid	C73	0	1985	2007	3.0	2.3	3.7	*
Malignant lymphoma	C81–C85 C96	0	1985	2007	1.2	0.8	1.6	*
Multiple myeloma	C88–C90	0	1985	2007	−0.1	−0.6	0.4	
Leukemia	C91–C95	0	1985	2007	−0.4	−0.8	0.0	*
Colon/rectum	C18–C20	1	1985	1995	4.8	4.0	5.7	*
			1995	2007	−0.3	−0.8	0.1	
Esophagus (including CIS)	C15 D001	0	1985	2007	1.2	0.8	1.6	*
Colon (including CIS)	C18 D010	1	1985	1995	5.5	4.5	6.5	*
			1995	2007	−0.5	−1.0	0.1	
Rectum (including CIS)	C19–C20 D011–D012	1	1985	1995	5.2	4.2	6.2	*
			1995	2007	0.4	−0.2	0.9	
Lung, trachea (including CIS)	C33–C34 D021–D022	1	1985	1996	1.5	1.1	1.8	*
			1996	2007	−0.1	−0.4	0.1	
Skin (including CIS)	C43–C44 D030–D049	0	1985	2007	2.6	2.0	3.3	*
Bladder (including CIS)	C67 D090	0	1985	2007	1.8	1.4	2.1	*
Colon/rectum (including CIS)	C18–C20 D010–D012	1	1985	1995	6.9	6.1	7.6	*
			1995	2007	0.4	0.0	0.8	

[a]Miyagi, Yamagata, Fukui and Nagasaki prefectures.
*Annual % change is statistically significantly different from zero.

Table 6. Results of Joinpoint regression analysis on the trends in cancer incidence by site (1985–2007), for females[a]

Cancer site	ICD-10	Number of joinpoints	Line segment		Annual % change	95% CI		
			Start	End		Lower	Upper	
Oral cavity and pharynx	C00–C14	0	1985	2007	1.1	0.1	2.0	*
Esophagus	C15	0	1985	2007	−0.3	−1.0	0.4	
Stomach	C16	0	1985	2007	−2.5	−2.7	−2.3	*
Colon	C18	1	1985	1995	3.3	2.3	4.3	*
			1995	2007	0.4	−0.2	1.0	
Rectum	C19–C20	1	1985	1998	1.4	1.0	1.8	*
			1998	2007	−1.1	−1.7	−0.4	*
Liver	C22	1	1985	1996	2.7	1.6	3.9	*
			1996	2007	−2.0	−3.0	−1.1	*
Gallbladder and bile ducts	C23–C24	1	1985	1998	−1.1	−1.8	−0.4	*
			1998	2007	−3.9	−5.1	−2.6	*
Pancreas	C25	0	1985	2007	0.8	0.5	1.2	*
Larynx	C32	0	1985	2007	−0.7	−3.1	1.7	
Lung, trachea	C33–C34	0	1985	2007	1.4	1.1	1.6	*
Skin	C43–C44	1	1985	1997	0.0	−1.3	1.3	
			1997	2007	4.5	3.0	6.0	*
Breast	C50	1	1985	1996	2.8	2.2	3.4	*
			1996	2007	4.4	3.9	4.9	*
Uterus	C53–C55	1	1985	1994	−1.3	−2.9	0.2	
			1994	2007	2.4	1.5	3.3	*
Cervix uteri	C53	1	1985	1997	−2.0	−3.4	−0.5	*
			1997	2007	1.5	−0.7	3.7	
Corpus uteri	C54	3	1985	1997	3.0	1.7	4.2	*
			1997	2000	10.8	−5.5	30.0	
			2000	2004	−1.0	−8.4	6.9	
			2004	2007	13.7	6.2	21.7	*
Ovary	C56	0	1985	2007	1.7	1.3	2.1	a
Bladder	C67	0	1985	2007	−0.4	−1.0	0.2	
Kidney and other urinary organs	C64–C66 C68	0	1985	2007	3.1	2.5	3.8	*
Brain, nervous system	C70–C72	0	1985	2007	−1.0	−1.9	0.0	*
Thyroid	C73	2	1985	1991	8.5	5.2	11.9	*
			1991	2002	−0.3	−1.6	1.0	
			2002	2007	4.5	1.0	8.2	*
Malignant lymphoma	C81–C85 C96	0	1985	2007	3.0	2.5	3.5	*
Multiple myeloma	C88–C90	0	1985	2007	−0.3	−0.9	0.3	
Leukemia	C91–C95	0	1985	2007	−0.2	−0.8	0.3	
Colon/rectum	C18–C20	1	1985	1996	2.6	1.9	3.2	*
			1996	2007	0.0	−0.5	0.5	
Esophagus (including CIS)	C15 D001	0	1985	2007	0.0	−0.8	0.7	
Colon (including CIS)	C18 D010	1	1985	1995	3.3	2.3	4.3	*
			1995	2007	0.4	−0.2	1.0	

Continued

Table 6. *Continued*

Cancer site	ICD-10	Number of joinpoints	Line segment		Annual % change	95% CI		
			Start	End		Lower	Upper	
Rectum (including CIS)	C19–C20 D011–D012	1	1985	1998	2.3	1.8	2.7	*
			1998	2007	−0.5	−1.2	0.1	
Lung, trachea (including CIS)	C33–C34 D021–D022	0	1985	2007	1.4	1.1	1.6	*
Skin (including CIS)	C43–C44 D030–D049	1	1985	1997	1.0	−0.4	2.4	
			1997	2007	5.0	3.6	6.5	*
Breast (including CIS)	C50 D05	1	1985	1996	2.8	2.2	3.5	*
			1996	2007	5.1	4.6	5.7	*
Uterus (including CIS)	C53–C55 D06	0	1985	2007	2.3	1.9	2.8	*
Cervix uteri (including CIS)	C53 D06	0	1985	2007	2.0	1.5	2.6	*
Bladder (including CIS)	C67 D090	0	1985	2007	1.1	0.5	1.6	*
Colon/rectum (including CIS)	C18–C20 D010–D012	1	1985	1995	4.0	3.4	4.6	*
			1995	2007	0.8	0.5	1.2	*

[a]Miyagi, Yamagata, Fukui and Nagasaki prefectures.
*Annual % change is statistically significantly different from zero.

or older) (22). These findings do not suggest that the implementation of cervical cancer screening programs has had a large impact on cancer trends. Regarding prognosis, the survival rate of uterine cancer did not change statistically significantly between the periods of 1993–1996 and 2000–2002 (12). The mortality rates of cancer of the corpus uteri have been increasing since the 1970s, a finding that likely indicates a shift from recording cancer of the 'uterus, NOS' to 'corpus uteri' in death certificates; however, the incidence of cancer of the corpus uteri also increased between 1985 and 1997, and after 2004.

The incidence of prostate cancer in Japan rapidly increased between 2000 and 2003. As the proportion of localized prostate cancers also rapidly increased during these years, the increased incidence can be interpreted to be a result of early diagnosis by prostate specific antigen testing. The mortality rate of prostate cancer started to decrease in 2004, immediately after the increase in incidence, although the mortality rate appears to have started leveling off as early as the mid-1990s (Fig. 2). Regarding prognosis, the population-based survival rate of prostate cancer improved statistically significantly between the periods of 1993–1996 and 2000–2002, which was interpreted as an improved prognosis for regional and distant stages (12).

The Basic Plan to Promote Cancer Control Programs (Basic Plan) was developed by the national government of Japan in June 2007. The 10-year goal of this plan was a 20% reduction in the ASR of all-cancer mortality below the age of 75 years. In the first 5 years since the Basic Plan was implemented, the APC in the ASR was 1.9 (95% CI: −2.2, −1.6). At this rate, the 10-year goal of the plan would be realized. However, our Joinpoint regression analysis did not detect any joinpoints after the baseline year of the Basic Plan, which indicates that the rate of cancer mortality decrease has not changed after implementation of the Basic Plan. To accelerate the decrease in all-cancer mortality, effective cancer control policies, such as tobacco control, evidence-based cancer screening and equalization of cancer care, need to be further promoted.

There are a few limitations in the present study. First, the trends in cancer incidence were analyzed using data collected in four prefectures, whose populations comprise 4.7% of the total Japanese population. Although the representativeness of the data was confirmed in a previous study for major cancers, an underestimation of the degree of the recent decline in female liver cancer was also reported (4). For minor cancers, it is possible that data from the four prefectures examined in the present study were not representative of the total Japanese population or that too few cases were analyzed to detect significant changes between years. Secondly, for both cancer incidence and mortality, we conducted trend analysis alone and provided only descriptive interpretations. However, many of the interpretations were based on previous literature using a more analytical framework.

In conclusion, our analysis of cancer trends in Japan revealed a recent decrease in mortality and a continuous increase in incidence. These trends are considered to be a result of changes in the underlying risk factors, such as tobacco smoking and infection, and are partially explained by early detection and improved treatment.

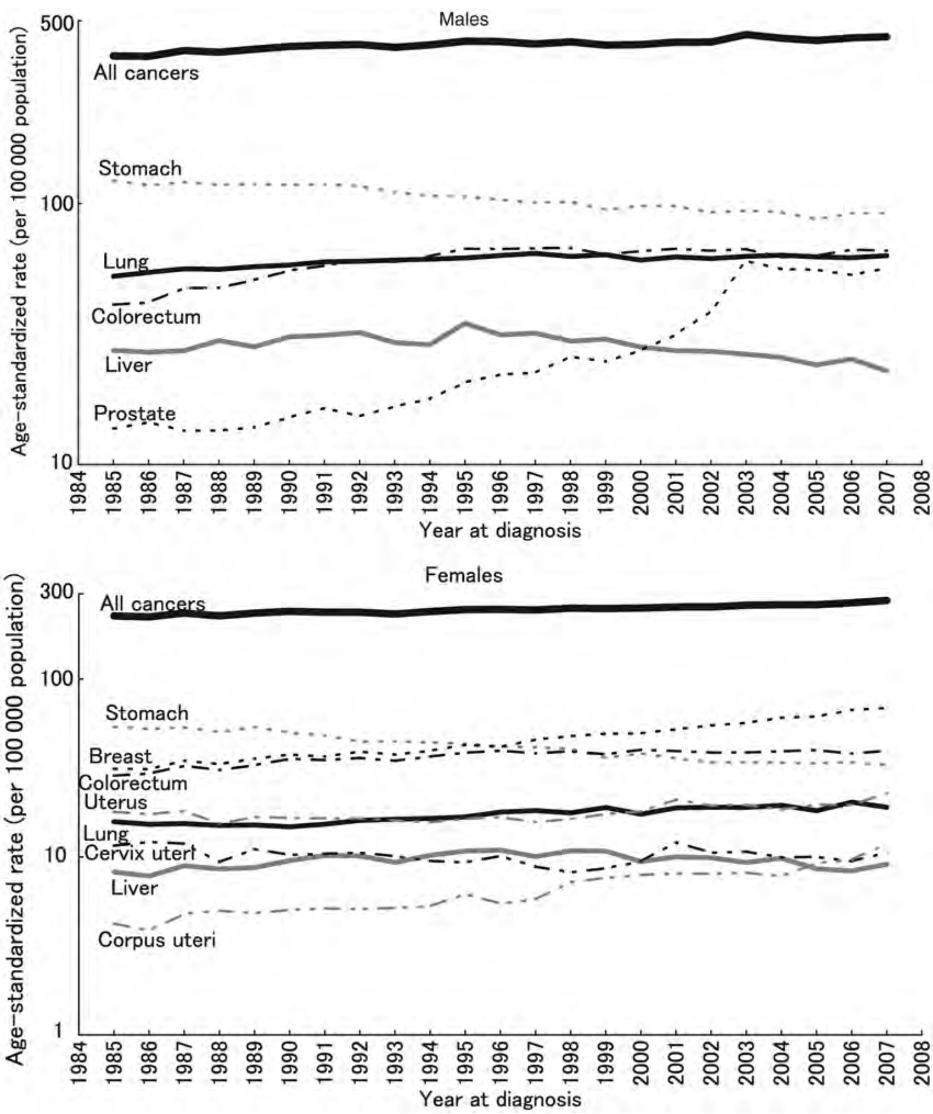

Figure 3. Trends in the ASR of all-cancer and site-specific cancer incidence: data from four prefectures (Miyagi, Yamagata, Fukui and Nagasaki prefectures).

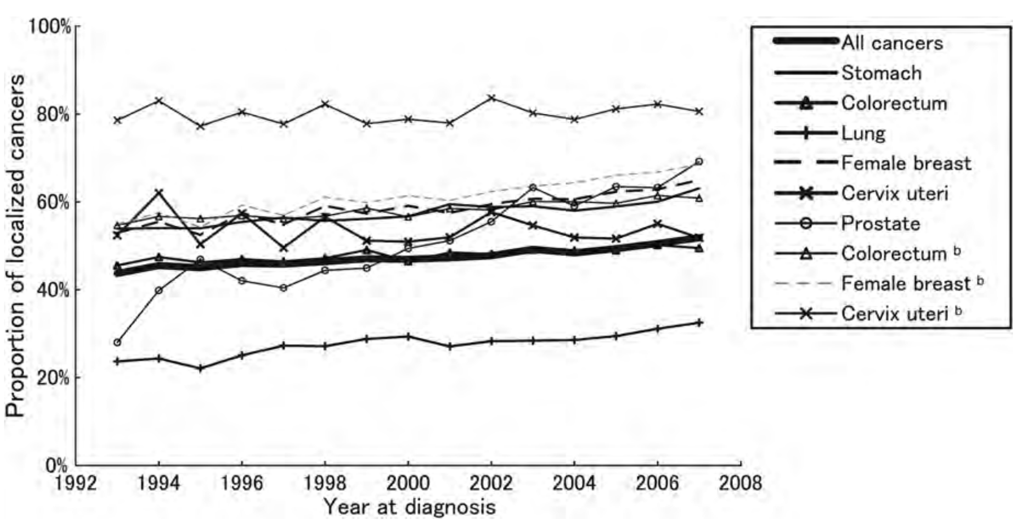

Figure 4. Trends in the proportion of cancers at the localized stage: data from four prefectures (Miyagi, Yamagata, Fukui and Nagasaki prefectures). [a]Cases with unknown stage were excluded for the calculation of proportions. [b]Including carcinoma *in situ*.

Funding

This work was supported by a Grant-in-aid for the Third-Term Comprehensive Ten-Year Strategy for Cancer Control from the Ministry of Health, Labour, and Welfare, Japan (24100601).

Conflict of interest statement

None declared.

References

1. Matsuda A, Matsuda T, Shibata A, et al. Cancer incidence and incidence rates in Japan in 2007: based on data from 21 population-based cancer registries in the Monitoring of Cancer Incidence in Japan (MCIJ) project. *Jpn J Clin Oncol* 2013;43:328–36.
2. Cancer incidence and incidence rates in Japan in 1988: estimates based on data from ten population-based Cancer Registries. The Research Group for Population-based Cancer Registration in Japan. *Jpn J Clin Oncol* 1994;24:299–304.
3. Qiu D, Katanoda K, Marugame T, Sobue T. A joinpoint regression analysis of long-term trends in cancer mortality in Japan (1958–2004). *Int J Cancer* 2009;124:443–8.
4. Katanoda K, Ajiki W, Matsuda T, et al. Trend analysis of cancer incidence in Japan using data from selected population-based cancer registries. *Cancer Sci* 2012;103:360–68.
5. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2012. *CA Cancer J Clin* 2012;62:10–29.
6. Vital Statistics Japan 2011. Ministry of Health, Labour and Welfare, editor. Tokyo: Health and Welfare Statistics Association 2012 [Japanese].
7. Population Files for Population-based Cancer Registry. Cancer Information Surveillance Division, Center for Cancer Control and Information Services, National Cancer Center, 2009; http://ganjoho.jp/pro/statistics/en/table_download.html (11 October 2012, date last accessed) [Japanese].
8. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for Joinpoint regression with applications to cancer rates. *Stat Med* 2000;19:335–51.
9. Tanaka J, Kumagai J, Katayama K, et al. Sex- and age-specific carriers of hepatitis B and C viruses in Japan estimated by the prevalence in the 3,485,648 first-time blood donors during 1995–2000. *Intervirology* 2004;47:32–40.
10. Yoshizawa H, Tanaka J, Miyakawa Y. National prevention of hepatocellular carcinoma in Japan based on epidemiology of hepatitis C virus infection in the general population. *Intervirology* 2006;49:7–17.
11. Tanaka H, Uera F, Tsukuma H, Ioka A, Oshima A. Distinctive change in male liver cancer incidence rate between the 1970s and 1990s in Japan: comparison with Japanese-Americans and US whites. *Jpn J Clin Oncol* 2007;37:193–6.
12. Matsuda T, Ajiki W, Marugame T, Ioka A, Tsukuma H, Sobue T. Population-based survival of cancer patients diagnosed between 1993 and 1999 in Japan: a chronological and international comparative study. *Jpn J Clin Oncol* 2011;41:40–51.
13. Kudo M. Early detection and curative treatment of early-stage hepatocellular carcinoma. *Clin Gastroenterol Hepatol* 2005;3: S144–8.
14. Katanoda K, Marugame T, Saika K, et al. Population attributable fraction of mortality associated with tobacco smoking in Japan: a pooled analysis of three large-scale cohort studies. *J Epidemiol* 2008;18:251–64.
15. Statitical Information, TOBACCO or HEALTH: Japan Health Promotion & Fitness Foundation. http://www.health-net.or.jp/tobacco/menu02.html (16 August 2012, date last accessed) [Japanese].
16. Revised Guidelines for Health Education for Cancer Prevention and Cancer Screening: Ministry of Health, Labour and Welfare, 2004; http://www.mhlw.go.jp/shingi/2004/04/s0427–2.html (14 November 2012, date last accessed) [Japanese].
17. Koike T, Yamato Y, Asamura H, et al. Improvements in surgical results for lung cancer from 1989 to 1999 in Japan. *J Thorac Oncol* 2009;4:1364–9.
18. Evidence Assessment, Development and Evaluation of Cancer Prevention Strategies in Japan: Epidemiology and Prevention Division, Research Center for Cancer Prevention and Screening. National Cancer Center, Japan. http://epi.ncc.go.jp/cgi-bin/cms/public/index.cgi/nccepi/en/can_prev/outcome/index (16 August 2012, date last accessed).
19. Inoue M, Sawada N, Matsuda T, et al. Attributable causes of cancer in Japan in 2005—systematic assessment to estimate current burden of cancer attributable to known preventable risk factors in Japan. *Ann Oncol* 2012;23:1362–9.
20. Asaka M, Kimura T, Kudo M, et al. Relationship of Helicobacter pylori to serum pepsinogens in an asymptomatic Japanese population. *Gastroenterology* 1992;102:760–6.
21. Tanaka M, Ma E, Tanaka H, Ioka A, Nakahara T, Takahashi H. Trends of stomach cancer mortality in Eastern Asia in 1950–2004: comparative study of Japan, Hong Kong and Singapore using age, period and cohort analysis. *Int J Cancer* 2012;130:930–6.
22. Cancer Screening Rate: Center for Cancer Control and Information Services. National Cancer Center, Japan, 2012; http://ganjoho.jp/public/statistics/pub/kenshin.html (25 December 2012, date last accessed) [Japanese].