

DIFFERENCES IN CANCER MORTALITY, INCIDENCE, AND EARLY DETECTION RATES AMONG EIGHT MEDICAL AREAS WITHIN AKITA PREFECTURE

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Abstract

The purpose of this study was to obtain basic data regarding the difference among medical area within Akita prefecture with which to formulate policies to reduce cancer mortality. We enrolled all cancer patients in Akita prefecture registered in “the population-based cancer register” between 2013 and 2017. The cancer standardized mortality rate, cancer standardized incidence rate, and early detection rate for gastric cancer, colorectal cancer, liver cancer, lung cancer, female breast cancer, and cervical cancer were analyzed in 8 medical areas within Akita prefecture (Daisen, Yokote, Yuzawa, Ohdate, Kita-akita, Noshiro, Akita, and Yuri-Honjo). This revealed that the cancer mortality, incidence rates and early detection differed among the medical areas evaluated. Low early detection rates were correlated with high cancer standardized mortality rates in nearly all areas. The immediate challenge differed among these areas, depending upon the cancer involved. In several medical areas the early lung cancer detection rate among men was only 20%. Early detection of cervical cancer was high, exceeding 80% in several areas. Based on these results, we suggest that implementing detailed cancer controls targeted to each medical area would be an effective way to reduce the cancer mortality rate in Akita prefecture.

Key words : cancer, mortality rate, incidence rate, early detection rate, medical area

Introduction

Cancer is currently the leading cause of death in Japan, accounting for about 30% of the total mortality, and the healthy life expectancy gap due to cancer is widening year by year and having a large impact, even in Japan^{1,2)}. Akita prefecture has one of the highest cancer

mortality rates in Japan and has been unable to reduce the rate for many years. To overcome this situation, the “Akita prefectural 3rd-term basic plan to promote cancer control programs” was established in March 2018, and with this plan the people in Akita are now endeavoring to reduce their cancer incidence within the prefecture.

Cancer registration is an information gathering system for obtaining indicators of cancer morbidity, survival rate, and actual medical care. This information is indispensable for cancer control and evaluation. Indeed, it is mandated under the law that cancer registration be actively utilized for cancer control. The present study aims to use “population-based cancer register” data to

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investigate the actual cancer mortality, incidence, and early detection rates in the various medical areas within Akita prefecture and to use the information gained for cancer control within Akita prefecture.

Methods

All patients registered for “the population-based cancer register” in Akita prefecture between 2013 and 2017 (5 years) were enrolled. Established by law in January 2016, this is a reliable and highly valuable cancer registry system that aggregates, analyzes, and manages data from all individuals diagnosed with cancer in Japan. After obtaining permission to study Akita prefecture, the data were collected and analyzed at the Center for Cancer Registry and Information Services at Akita University Hospital. Investigated were gastric cancer, colorectal cancer, liver cancer, lung cancer, and female breast cancer, all of which are common in Japan and have effective screening. We analyzed the cancer standardized mortality rate (SMR) and the cancer standardized incidence rate (SIR) in 8 medical areas in which patients reside within

Akita prefecture (Daisen, Yokote, Yuzawa, Ohdate, Kitakita, Noshiro, Akita, and Yuri-Honjo). Because mortality and incidence rates usually vary greatly depending on age, it is not possible to directly compare mortality and incidence rates between regions with different age structures. For SMRs and SIRs, mortality and incidence rates were calculated by age group in each region according to the standard age structure. Therefore, the SMR was defined as (Numbers of cancer deaths in the area / Expected numbers of deaths in the area) \times 100, and the SIR was defined as (Numbers of cancer incidences in the area / Expected numbers of incidences in the area) \times 100. The SMR and SIR are relative rates expressed as ratios to the entire Akita prefecture, which was assigned a value of 1.00, and analyzed in the 8 medical areas. Thus, the SMR or SIR in each medical area will be 1.00 if it is the same as that for Akita prefecture as a whole; it will be more than 1 if it is higher than that for Akita prefecture as a whole and less than 1 if it is lower.

The definitions of early detection were “carcinoma in situ” and “localized cancer” (cancer without lymph node metastasis, distant organ metastasis or invasion to adja-

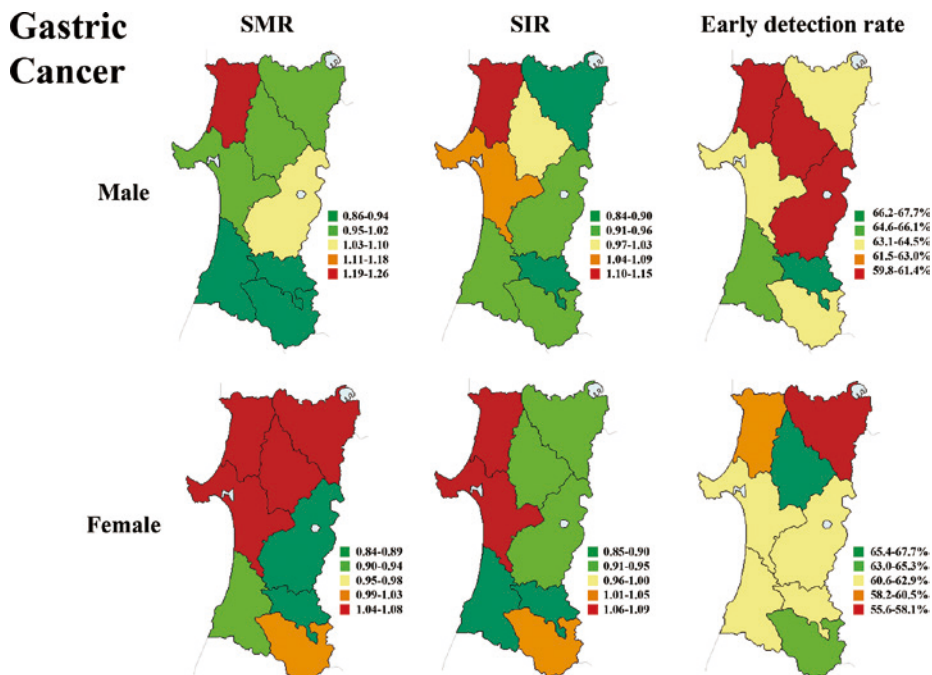


Figure 1. Standardized mortality rate (SMR), standardized incidence rate (SIR) and early detection rate for gastric cancer.

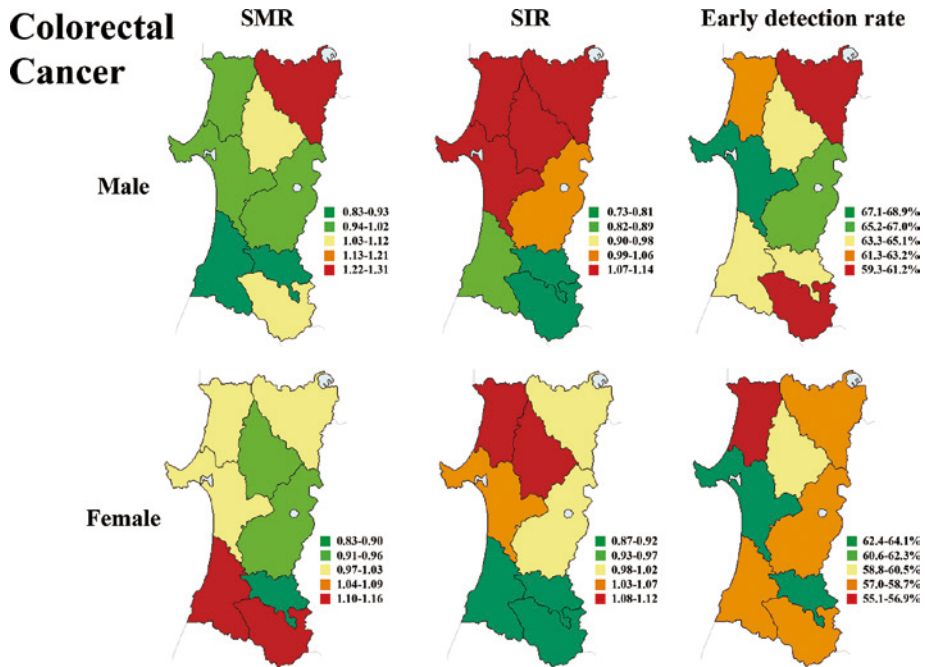


Figure 2. Standardized mortality rate (SMR), standardized incidence rate (SIR) and early detection rate for colorectal cancer.

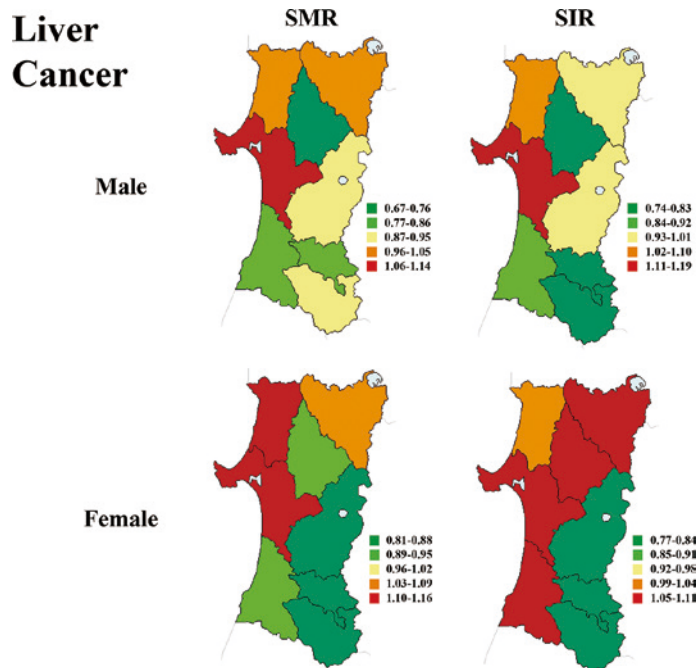


Figure 3. Standardized mortality rate (SMR) and standardized incidence rate (SIR) for liver cancer.

(10)

Differences among medical areas

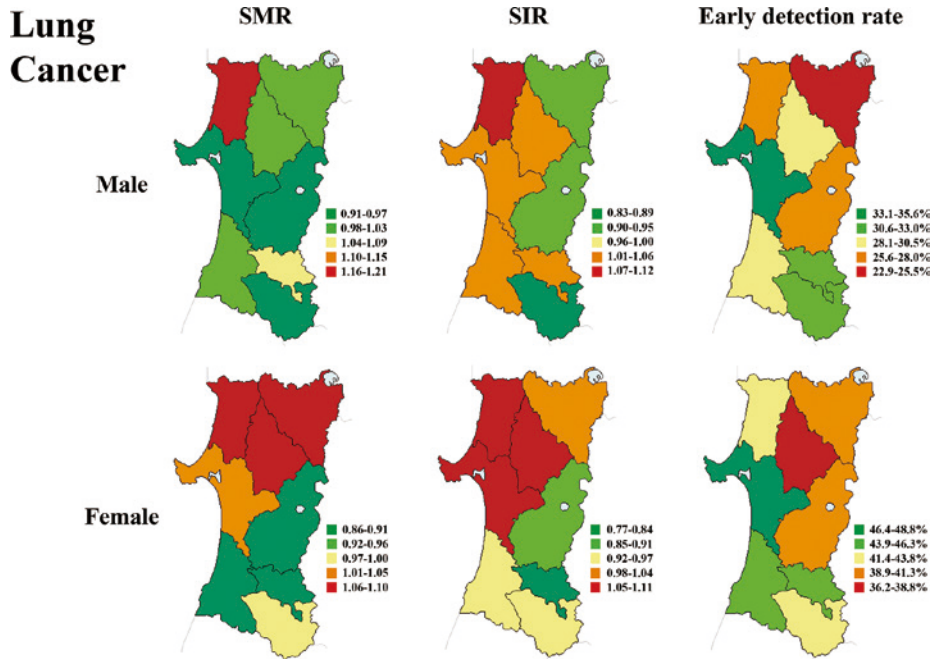


Figure 4. Standardized mortality rate (SMR), standardized incidence rate (SIR) and early detection rate for lung cancer.

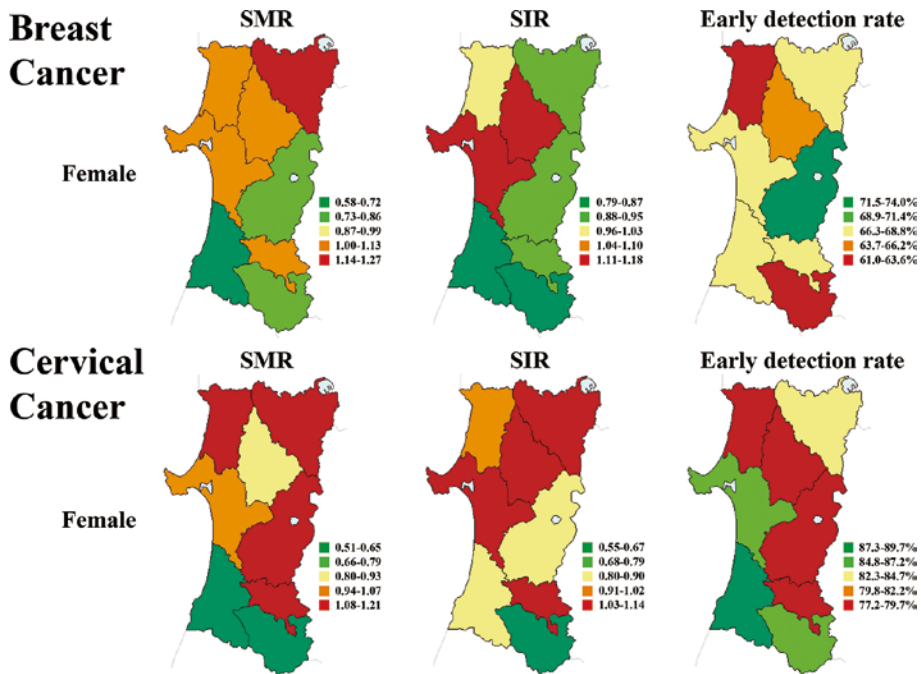


Figure 5. Standardized mortality rate (SMR), standardized incidence rate (SIR) and early detection rate for female breast cancer (upper row) and cervical cancer (lower row).

cent structure) at the time of diagnosis. This is an important indicator of the frequency of early diagnosis. The early detection rate was analyzed for each cancer type excluding the liver cancer. Color maps of SMR, SIR, and early detection rate were created to visualize the obtained results in an easy-to-understand manner. The scales of the maps were color-coded by dividing the range between the maximum and minimum values into five equal parts.

This study was conducted in accordance with the spirit of the Declaration of Helsinki (World Medical Association) and according to the “*Ethical guidelines for epidemiological research*” from the Ministry of Education, Culture, Sports, Science and Technology, Ministry of Health, Labor and Welfare). It was also approved by the Akita University Graduate School of Medicine (No. 2463).

Results

The SMR, SIR and early detection rate in both males and females in each medical area are presented in Tables 1-3.

In the Daisen medical area, the SMR for cervical cancer was 1.14 with a low early detection rate (78.7%). On the other hand, the SMRs for female gastric, liver and breast cancers were 0.84, 0.82 and 0.83, respectively. The immediate challenge in this area is to reduce mortality through early diagnosis of cervical cancer by screening (Table 4).

In the Yokote medical area, the SMR for cervical cancer was the highest (1.21) among the 8 areas evaluated, and the early detection rate was lowest (77.2%). On the other hand, the SMRs and SIRs for gastric, colorectal, and liver cancer were more than 10% lower than that for the prefecture as a whole, with high early detection rates for gastric cancer in males and colorectal cancer in females. The immediate challenge in this area is to reduce the high mortality rate due to cervical cancer through early diagnosis by screening.

In the Yuzawa medical area, the SMR for colorectal cancer in females was the highest among the 8 evaluated areas (1.16). Notably, the SIR was only 0.91, but the early detection rate was very low (58.2%). This pattern of low incidence with very low early detection leading to

high mortality illustrates a worst case scenario. On the other hand, both the SMR and SIR for cervical cancer were extremely low (0.51 and 0.55) with a high early detection rate (86.7%). However, early detection of breast cancer was lowest among the evaluated areas (61.0%). The immediate challenge in this area is to reduce the high colorectal cancer mortality in females through early diagnosis by screening and to increase early detection of breast cancer.

In the Ohdate medical area, the SMR for colorectal cancer in males was extremely high (1.31). Although the SIR was only 1.07, the early detection rate was the lowest among males (59.3%). This shows a clear deficiency in the screening system for colorectal cancer in males in this area. The SMRs for breast and cervical cancers were 1.27 and 1.19, respectively, though the SIRs were 0.92 and 1.05. The SMR and SIR for lung cancer in males was not critical, but the early detection rate was extremely low (22.9%). The immediate challenge in this area is to reduce the high colorectal cancer mortality in males and to increase early detection of breast and cervical cancer in females and lung cancer in males.

In the Kita-akita medical area, sample size was very small. The SMR and SIR for breast cancer were 1.13 and 1.18, respectively, with a low early detection rate (63.9%). The immediate challenge in this area is to reduce the high breast cancer mortality.

In the Noshiro medical area, the SMR and SIR for gastric cancer in males were the highest at 1.26 and 1.15, respectively, and the early detection rate was low (60.7). In addition, the SMRs for lung cancer in males and females were the highest (1.21 and 1.10) and were accompanied by very low early detection rates (27.2 and 42.0). The SIR in males was highest (1.12) among the 8 areas evaluated, indicating effective prevention and early screening is urgently needed in this area. The SMRs for liver and cervical cancers in females were 1.13 and 1.19, respectively, though the SIRs were only 1.02 and 0.93. The immediate challenge in this area is to reduce the high mortality due to gastric cancer in males, lung cancer in both males and females, and liver and cervical cancers in females through early detection of gastric, lung, breast, and cervical cancer.

In the Akita medical area, the most populous area in

Table 1-1. Standardized mortality ratio (SMR) in each medical area of Akita prefecture (2013-2017, Male)

Medical area	Gastric Cancer		Colorectal Cancer		Liver cancer		Lung Cancer		Expected numbers of deaths	
	SMR	Numbers of cancer deaths	SMR	Numbers of cancer deaths	SMR	Numbers of cancer deaths	SMR	Numbers of cancer deaths		
Daisen	1.07	313	0.96	202	0.94	94	100.1	0.93	332	355.5
Yokote	0.89	186	0.83	125	0.83	59	71.3	1.09	277	254.7
Yuzawa	0.91	140	1.04	116	0.95	49	51.9	0.91	171	187.1
Ohdate	0.98	242	1.31	232	1.05	89	85.0	0.99	298	300.5
Kita-akita	0.98	90	1.12	73	0.67	21	31.2	1.03	115	111.7
Noshiro	1.26	242	1.00	137	1.03	68	66.1	1.21	282	233.6
Akita	1.01	754	0.96	521	1.14	298	261.5	0.97	883	911.0
Yuri-Honjo	0.86	189	0.92	146	0.86	65	76.0	0.98	264	268.3

Table 1-2. Standardized mortality ratio (SMR) in each medical area of Akita prefecture (2013-2017, Female)

Medical area	Gastric Cancer		Colorectal Cancer		Liver cancer		Lung Cancer		Breast Cancer		Cervical Cancer				
	SMR	Numbers of cancer deaths	SMR	Numbers of cancer deaths	SMR	Numbers of cancer deaths	SMR	Numbers of cancer deaths	SMR	Numbers of cancer deaths	SMR	Numbers of cancer deaths			
Daisen	0.84	146	0.93	178	0.82	43	52.2	0.91	135	0.83	67	80.9	1.14	45	39.4
Yokote	0.86	104	0.83	112	0.83	30	36.2	0.91	94	1.08	61	103.2	1.21	33	27.4
Yuzawa	1.03	89	1.16	111	0.81	21	25.9	0.97	71	0.85	34	40.2	0.51	10	19.5
Ohdate	1.08	160	1.03	169	1.03	46	44.9	1.08	137	1.27	88	127.4	1.19	40	33.5
Kita-akita	1.07	59	0.95	58	0.90	15	16.6	1.09	51	1.13	27	23.9	0.86	10	11.6
Noshiro	1.05	123	0.98	127	1.13	40	35.3	1.10	110	1.03	55	100.3	1.19	31	26.1
Akita	1.07	448	1.02	470	1.16	145	124.6	1.05	378	1.08	238	360.1	1.01	108	107.5
Yuri-Honjo	0.93	119	1.10	156	0.89	34	38.4	0.86	94	0.58	36	61.9	0.60	18	30.1

Table 2-1. Standardized incidence ratio (SIR) in each medical area of Akita prefecture (2013-2017, Male)

Medical area	Gastric Cancer			Colorectal Cancer			Liver cancer			Lung Cancer		
	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences
Daisen	0.96	772	802.3	1.00	666	664.0	0.93	121	130.7	0.92	465	502.8
Yokote	0.90	514	571.5	0.73	344	472.5	0.75	70	93.1	1.02	365	358.6
Yuzawa	0.94	390	415.6	0.81	278	344.1	0.74	50	67.7	0.83	217	261.6
Ohdate	0.84	575	682.7	1.07	606	564.7	0.95	106	111.1	0.91	390	426.6
Kita-akita	1.01	249	247.6	1.07	216	202.6	0.74	30	40.3	1.02	159	156.1
Noshiro	1.15	608	529.5	1.14	498	436.7	1.03	89	86.3	1.12	371	331.3
Akita	1.06	2,268	2,135.6	1.07	1,923	1,794.4	1.19	415	348.3	1.02	1,349	1,319.7
Yuri-Honjo	0.91	558	615.6	0.85	438	513.3	0.91	91	100.4	1.04	397	383.6

Table 2-2. Standardized incidence ratio (SIR) in each medical area of Akita prefecture (2013-2017, Female)

Medical area	Gastric Cancer			Colorectal Cancer			Liver cancer			Lung Cancer			Breast Cancer			Cervical Cancer		
	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences	SIR	Numbers of cancer incidences	Expected numbers of cancer incidences
Daisen	0.92	369	402.0	0.98	522	530.8	0.79	55	69.8	0.90	223	249.0	0.90	426	474.3	0.89	46	51.7
Yokote	0.85	236	277.3	0.87	319	366.8	0.77	37	48.0	0.77	133	171.9	0.92	305	330.4	1.05	38	36.2
Yuzawa	1.05	208	198.1	0.91	238	262.0	0.81	28	34.4	0.96	118	122.7	0.83	196	235.4	0.55	14	25.3
Ohdate	0.95	329	346.9	0.98	449	456.8	1.11	67	60.3	1.00	215	215.0	0.92	372	405.8	1.05	46	44.0
Kita-akita	0.95	119	125.1	1.12	184	163.6	1.05	23	22.0	1.11	85	76.9	1.18	160	135.6	1.14	16	14.1
Noshiro	1.09	297	271.4	1.11	397	357.1	1.02	48	47.2	1.07	180	168.1	1.02	320	312.5	0.93	31	33.2
Akita	1.08	1,088	1,011.2	1.03	1,399	1,355.1	1.09	186	170.7	1.08	686	637.3	1.13	1,549	1,373.3	1.09	172	157.2
Yuri-Honjo	0.87	262	300.0	0.88	350	397.9	1.07	55	51.6	0.97	182	187.0	0.79	292	367.9	0.87	35	40.4

Table 4. The challenge for cancer control in each medical area

Medical area	Target	SMR	SIR	Early detection
Daisen	Cervical cancer	↑		↓
Yokote	Cervical cancer	↑↑		↓↓
Yuzawa	Colorectal cancer (F)	↑↑	↓	↓
	Breast cancer			↓↓
Ohdate	Colorectal cancer (M)	↑↑		↓↓
	Breast cancer	↑↑		
	Cervical cancer	↑↑		
	Lung cancer (M)			↓↓
Kita-akita	Breast cancer	↑	↑	
Noshiro	Gastric cancer (M)	↑↑	↑↑	↓
	Lung cancer (M)(F)	↑↑	↑↑	↓
	Liver cancer (F)	↑		
	Cervical cancer	↑		
Akita	Liver cancer (M)(F)	↑		
Yuri-Honjo	Colorectal cancer (F)	↑		

M ; male, F ; female, SMR ; standardized mortality ratio, SIR ; standardized incidence ratio

the prefectural capital, the SMR and SIR for liver cancer in males and females were more than 10% higher than for the prefecture as a whole. For all other cancers, SMRs and SIRs were the same as that for all of Akita prefecture.

In the Yuri-Honjo medical area, the SMR for colorectal cancer in females was 1.10, though the SIR was only 0.88. The SMRs for breast and cervical cancers were extremely low (0.58 and 0.60) with low SIRs (0.79 and 0.87). The early detection rate for cervical cancer was the highest (89.7%). The immediate challenge in this area is to reduce colorectal cancer mortality in females.

Discussion

The following was clarified in this study. The SMRs, SIRs and early detection rates differed among the 8 medical areas evaluated in Akita prefecture. Low early detection rates correlated with high SMRs in nearly all areas, and the immediate challenge differed among areas depending on the cancer involved. For example, in several medical areas the early detection rate for lung cancer among men was only 20%, whereas the early detection rate for cervical cancer was high, exceeding 80% in sev-

eral areas.

Areas such as Akita prefecture, which has a large geographical area with low population density, have various problems peculiar to them. First, the population decline outside the Akita medical area, where the prefectural capital is located, is accelerating. According to the Basic Resident Register in 2016, aside from the Akita medical area, which has a population of around 400,000, the populations of the other 7 medical areas in Akita prefecture are small, ranging from 36,000 to 134,000. At the same time, these populations are rapidly aging. This is noteworthy, as aging is directly linked to cancer incidence and death, has an adverse effect on early detection and treatment, and makes countermeasures more difficult. Against this background, uniform cancer control measures for entire prefectures are not effective. There was hope that this might be possible, but there is no reliable data to support it. This time, we were able to analyze cancer SMRs, SIRs, and early detection rates for each medical area within Akita prefecture. This material will provide useful information for policy making to reduce the cancer mortality rate and promote cancer control in Akita prefecture.

With respect to gastric cancer, Akita prefecture has had

the highest mortality rate in Japan for many years, prompting strong cancer control measures to be taken. Nonetheless, while the gastric cancer morbidity rate is declining nationwide, in Akita prefecture it has remained flat and continues to be a major issue³⁾. In this survey, the high gastric cancer morbidity and mortality rate in the Noshiro medical area (population : 85,000) was conspicuous. Especially among men, the SMR was extremely high at 1.26, and we suggest that a program of early detection through gastric cancer screening using targeted upper gastrointestinal endoscopy should be initiated immediately as a pilot project in this area. The 5-year survival rate for gastric cancer detected at Stage I is more than 95% (National Cancer Center Cancer Information Service), and it appears that the mortality rate could be improved by increasing the current early detection rate by 10%. Considering the cost of examination, we recommend endoscopic examination beginning with the generation just before the age of prevalence. On the other hand, in the Yokote medical area (population : 94,000), not only are the gastric cancer morbidity and mortality rates low, but the early detection rate is high. We hope that a new solution will be discovered through detailed analysis of this positive finding.

Colorectal cancer morbidity and mortality are also rising in Akita prefecture as a whole, and a more detailed analysis of the current situation will be conducted in each region to investigate how to increase the early detection rate in regions with high morbidity and mortality. The SMRs are high among males in Ohdate and among females in Yuzawa, and early detection rates are low in both. Early detection rates in these two areas could be increased by using a simple fecal occult blood test. However, among females in the Yuri-Honjo area, the SMR was high but the SIR was not, and the early detection rate was low. Further evaluation of this area is necessary to improve cancer mortality.

Liver cancer is declining nationwide in Japan as a result of effective measures against infectious diseases. The morbidity rate is particularly low in Akita prefecture, and the mortality rate is correspondingly low. However, an analysis of secondary medical areas revealed that the morbidity and mortality rates are high in the Akita medical area, which has the largest population in the prefec-

ture. Unlike other cancers, objective data on the rate of early detection is not provided for liver cancer.

Rising lung cancer mortality has recently become a major challenge in Akita prefecture. The "Akita prefectural 3rd-term basic plan to promote cancer control programs" focused on smoking cessation and prevention of passive smoking with the aim of preventing lung cancer and reducing mortality⁴⁾. Our analysis revealed an increase in mortality and a decrease in the early detection rate in the Noshiro medical area, but no other trends were seen. We believe that all prefectures should work together to implement the tobacco control measures outlined in the third plan.

For female breast cancer, the SMR was notably high in the Ohdate medical area. In addition, we found that both the SIR and SMR were both high in the Kita-akita medical area (population : 36,000) and that the early detection rate was low. Early detection measures are greatly needed in these two medical areas in the north of the prefecture. On the other hand, in the Yuri-Honjo area, both the SMR and SIR were low. In the Daisen medical area (population : 134,000), the SMR was quite low and the SIR was also low, while rates of early detection were high. A similar result was obtained in the Yuzawa medical area. It will be important to analyze these good results from the south of the prefecture to identify beneficial measures and to then apply those measures in the aforementioned areas in the north of the prefecture (Ohdate and Kita-akita medical areas).

Cervical cancer has been on a downward trend for several years nationwide, due in part to measures against infectious diseases. However, the incidences of cervical cancer have recently begun to level off in Akita prefecture. It goes without saying that the wide application of the human papillomavirus vaccine is the most important measure, and the country has begun to focus on vaccination, which was once stopped. In the Yokote and Daisen medical areas, SMRs were substantially higher than in the prefecture as a whole, and early detection rates were low. By contrast, in the Ohdate and Noshiro medical areas, SMRs were low and were accompanied by higher early detection rates. It is noteworthy that in the Yuzawa area, both the SMR and SIR were low, and the early detection rate was high. By analyzing these positive re-

sults, it may be possible to develop more effective measures to further reduce the incidence of cervical cancer.

In this study, we found a gender gap in the SMR, even within the same medical area. After dividing the Akita prefecture into 8 medical areas with small populations, further division based on gender make the number of subjects analyzed even smaller, making them unreliable low-power data. Nevertheless, it has long been recognized that there is a gender gap in cancer mortality, as was seen in the present study^{5,6)}. Behaviors aimed at cancer prevention, including cancer screening, differ greatly depending on gender^{5,6)}. Moreover, it is recognized worldwide that the cancer mortality rate cannot be improved unless this gap is removed, and it is anticipated that interest in solving this problem will continue to grow in the future^{5,6)}. In the present study, for example, the rate of early detection of lung cancer varied greatly between genders and was higher in females. Differences in smoking rates appear to be the reason, though there were also regional differences in mortality. On the other hand, in gastric and colorectal cancers, the early detection rate among men was relatively high but was not linked to a reduction in the mortality rate. It is presumed that various complicating factors are intertwined in those findings. Especially for cancers for which screening and prevention are effective, it is extremely important to improve behaviors aimed at early detection. The results of this study linking early cancer detection rates to both gender and area will be useful for reducing cancer mortality in Akita prefecture.

There are several limitations to this study. 1) After dividing Akita Prefecture, which has a small population, into 8 medical areas, the size of the analyzed sample was small in some cases. 2) In addition, the analysis ignores the background of the patients and the stages of their cancers. 3) The analysis is based on the patient's place of residence and does not consider movement beyond the medical area.

Akita prefecture is large in area, and each region has its own culture and lifestyle. Consequently, dividing the prefecture into eight medical areas provided a means for effective analysis, as the results show. Based on these results, we are convinced that implementing more detailed cancer control measures that target each medical

area will be the most effective way to reduce the cancer mortality rate in Akita prefecture as a whole.

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Conflict of interest

The authors have no conflicts of interest to declare.

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