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Cancer Incidence and Incidence Rates in Japan in 2005: Based on Data from 12 Population-based Cancer Registries in the Monitoring of Cancer Incidence in Japan (MCIJ) Project

Tomohiro Matsuda[1,*], Tomomi Marugame[1], Ken-ichi Kamo[2], Kota Katanoda[1], Wakiko Ajiki[1] and Tomotaka Sobue[1] The Japan Cancer Surveillance Research Group

[1]Cancer Information Services and Surveillance Division, Center for Cancer Control and Information Services, National Cancer Center, Tokyo and [2]Division of Mathematics, School of Medicine, Liberal Arts and Sciences, Sapporo Medical University, Sapporo, Hokkaido, Japan

*For reprints and all correspondence: Tomohiro Matsuda, 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: tomatsud@ncc.go.jp

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The Japan Cancer Surveillance Research Group estimated the cancer incidence in 2005 as part of the Monitoring of Cancer Incidence in Japan (MCIJ) project, on the basis of data collected from 12 of 30 population-based cancer registries. The total number of incidences in Japan for 2005 was estimated as 646 802 (C00–C96). The leading cancer site was the stomach for men and the breast for women. Age-standardized incidence rates remained almost the same level as the previous 2 years.

Key words: cancer incidence – incidence estimates – cancer registry – Japan

The Japan Cancer Surveillance Research Group is involved in cancer monitoring in Japan since 2000 (1–5). This group estimated the cancer incidence in 2005 as part of the Monitoring of Cancer Incidence in Japan (MCIJ) project, on the basis of data collected from 12 of 30 population-based cancer registries: Miyagi, Yamagata, Chiba, Kanagawa, Niigata, Fukui, Shiga, Tottori, Okayama, Hiroshima, Nagasaki and Kumamoto. If data from all 30 registries were used, this would have led to a large underestimation of national cancer incidence because of under-registration. The methods of registry selection, estimation of incidence and the limitations of these methods have been explained in previous studies (6–8). We maintained the same methodology since the MCIJ2003: (i) we invited all 30 population-based cancer registries in Japan to participate, and from these, we selected the 12 cancer registries with high-quality data in order to estimate the national incidence, and (ii) we used 2005 data alone for the national estimation. For this year, data from Osaka and Saga prefectures, regularly considered as one of the registries with high quality, were not available for the MCIJ project. The other registries remained since the previous estimation in 2004.

The number of incidences, crude rates, age-standardized rates and quality indicators of registration in 2005 are shown in Table 1, and the age-specific number of incidences and the rates according to sex and primary site are shown in Tables 2 and 3. The total number of incidences in Japan for 2005 was estimated as 646 802 (C00–C96). The time trends of age-standardized incidence rates for the five major sites and male- and female-specific sites in 1975–2005 are shown in Fig. 1 (standard population: the world population) and in Fig. 2 (standard population: the 1985 Japanese model population). The leading cancer site according to the crude and age-standardized incidence rates was the stomach for men and the breast for women since the research group took over national estimation of incidence, as shown in Figs 1 and 2. Age-standardized incidence rates remained almost the same level as the previous 2 years. It is thought to be partly due to that the development of hospital-based cancer registry in designated cancer care hospitals was calmed down in 2005. The estimated cancer incidence data in Japan by sex, site, 5-year age group and calendar year during the period 1975–2005 are available as a booklet and as an electronic database

Table 1. Incidence, completeness of reporting and accuracy of diagnosis in Japan according to sex and primary site, 2005

Primary sites	ICD-10th	Number of incidence	Crude rate[a]	Age-standardized rate[a]		Completeness of reporting		Accuracy of diagnosis
				World population	Japanese 1985 model population	DCO/I (%)	I/M	MV/I (%)
Male								
All sites (incl. CIS)	C00–C96, D00–D09	390 835	626.9	288.5	408.4	14.9	1.99	74.8
All sites	C00–C96	379 436	608.6	279.7	396.1	15.2	1.93	74.3
Lip, oral cavity and pharynx	C00–C14	7417	11.9	6.0	8.2	12.8	1.79	80.6
Esophagus	C15	14 818	23.8	11.1	15.5	13.1	1.57	80.0
Stomach	C16	80 102	128.5	59.3	83.9	12.1	2.45	84.0
Colon	C18	37 126	59.5	27.1	38.7	10.3	2.76	84.1
Rectum	C19–C20	22 344	35.8	17.5	24.2	10.3	2.57	85.3
Colon and rectum	C18–C20	59 470	95.4	44.6	62.9	10.3	2.69	84.6
Liver	C22	28 729	46.1	21.4	30.1	23.5	1.24	31.3
Gallbladder etc.	C23–C24	9237	14.8	6.1	9.1	25.3	1.18	48.8
Pancreas	C25	13 108	21.0	9.5	13.5	26.5	1.07	35.9
Larynx	C32	3903	6.3	2.9	4.0	6.1	3.88	89.3
Trachea, bronchus and lung	C33–C34	58 264	93.4	39.4	58.5	21.7	1.29	68.8
Melanoma of skin etc.	C43–C44	4798	7.7	3.5	5.0	4.2	7.64	92.5
Prostate	C61	42 997	69.0	28.2	42.0	10.3	4.64	83.5
Bladder	C67	12 619	20.2	8.8	12.9	10.3	3.05	83.2
Kidney, renal pelvis, ureter etc.	C64–C66, C68	9758	15.7	7.7	10.6	13.2	2.43	76.1
Brain and nervous system	C70–C72	2496	4.0	2.8	3.3	25.3	2.71	68.2
Thyroid	C73	2126	3.4	2.0	2.6	4.5	4.77	91.0
Malignant lymphoma	C81–C85, C96	9667	15.5	8.0	10.9	12.4	1.99	86.1
Multiple myeloma	C88, C90	2242	3.6	1.5	2.3	23.2	1.14	67.4
All leukaemias	C91–C95	5200	8.3	5.3	6.3	21.6	1.21	85.9

Female								
All sites (incl. CIS)	C00–C96, D00–D09	285 240	436.0	202.6	271.1	15.0	2.21	74.9
All sites	C00–C96	267 366	408.7	183.8	247.7	15.8	2.07	73.7
Lip, oral cavity and pharynx	C00–C14	3498	5.3	2.3	3.1	14.6	2.29	80.4
Esophagus	C15	2678	4.1	1.5	2.1	20.9	1.56	71.6
Stomach	C16	37 035	56.6	21.8	30.7	15.6	2.10	80.2
Colon	C18	31 069	47.5	17.9	25.1	14.3	2.27	79.5
Rectum	C19–C20	13 517	20.7	8.9	12.1	11.0	2.70	83.8
Colon and rectum	C18–C20	44 586	68.2	26.8	37.2	13.3	2.39	80.7
Liver	C22	13 465	20.6	6.9	10.1	27.6	1.22	26.7
Gallbladder etc.	C23–C24	9399	14.4	4.0	6.1	30.9	1.08	38.4
Pancreas	C25	11 691	17.9	5.8	8.4	28.8	1.10	30.7
Larynx	C32	214	0.3	0.1	0.2	16.2	2.55	73.7
Trachea, bronchus and lung	C33–C34	25 617	39.2	14.3	20.2	23.3	1.52	68.0
Melanoma of skin etc.	C43–C44	4342	6.6	2.3	3.2	8.2	7.50	90.1
Breast (incl. CIS)	C50, D05	50 695	77.5	47.5	61.4	5.0	4.73	90.4
Breast (only invasive)	C50	47 583	72.7	44.4	57.4	5.3	4.44	89.9
Uterus (incl. CIS)	C53–C55, D06	25 424	38.9	27.5	34.3	5.5	4.73	89.9
Uterus (only invasive)	C53–C55	17 476	26.7	16.4	21.1	7.4	3.25	87.2
Cervix uteri	C53	8474	13.0	8.7	11.0	6.1	3.44	88.6
Corpus uteri	C54	8189	12.5	7.3	9.5	3.2	5.61	92.1
Ovary	C56	8304	12.7	7.4	9.4	13.4	1.86	77.7
Bladder	C67	3858	5.9	1.8	2.7	19.8	2.04	71.7
Kidney, renal pelvis, ureter etc.	C64–C66, C68	4884	7.5	3.1	4.2	16.8	2.31	71.4
Brain and nervous system	C70–C72	2567	3.9	2.3	2.7	28.2	3.49	64.6
Thyroid	C73	7093	10.8	6.7	8.5	7.5	6.93	88.5
Malignant lymphoma	C81–85 C96	7324	11.2	5.0	6.6	13.7	1.97	83.7
Multiple myeloma	C88 C90	2171	3.3	1.2	1.7	26.3	1.13	66.8
All leukaemias	C91–C95	3832	5.9	3.4	4.0	22.6	1.29	83.5

ICD-10th, International Classification of Disease, 10th Revision; DCO/I, proportion of cases with the death certificate only to incident cases; I/M, number of incidence/number of deaths; MV/I, proportion of microscopically verified cases to incident cases; CIS, carcinoma *in situ*.
[a]Per 100 000 population.

Table 2. Age-specific incidence in Japan according to sex and primary site, 2005

Primary sites	ICD-10th	Age group (years)																	
		0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85+
Male																			
All sites (incl. CIS)	C00–C96, D00–D09	411	251	264	325	694	915	1592	2633	4640	7543	17 618	34 039	47 157	60 310	73 404	69 067	40 247	29 725
All sites	C00–C96	411	247	264	320	694	895	1577	2540	4422	7221	16 847	32 892	45 627	58 269	71 267	67 254	39 392	29 297
Lip, oral cavity and pharynx	C00–C14	1	7	14	2	36	39	58	71	123	261	543	1125	1157	1040	1060	1054	494	332
Esophagus	C15	0	2	0	0	0	0	0	22	61	304	717	1779	2364	2846	2604	2304	1196	619
Stomach	C16	4	0	0	6	46	66	168	435	1060	1708	4174	7786	10 330	12 802	14 933	13 373	7552	5659
Colon	C18	0	0	0	6	1	62	115	311	456	658	1786	3257	4635	5947	6828	6253	3979	2832
Rectum	C19–C20	0	0	0	5	4	20	120	171	406	734	1437	2830	3320	3508	3825	3184	1640	1140
Colon and rectum	C18–C20	0	0	0	11	5	82	235	482	862	1392	3223	6087	7955	9455	10 653	9437	5619	3972
Liver	C22	15	0	0	0	6	22	56	160	271	501	1523	2795	4111	4824	5840	4716	2448	1441
Gallbladder etc.	C23–C24	0	0	0	0	11	1	0	41	24	77	282	481	877	1241	1541	1908	1481	1272
Pancreas	C25	0	0	1	0	0	10	7	59	114	181	698	1216	1625	2214	2301	2049	1503	1130
Larynx	C32	0	0	0	0	0	0	0	12	23	28	160	454	723	690	550	721	343	199
Trachea, bronchus and lung	C33–C34	0	0	5	0	0	46	71	205	388	802	1889	4084	6049	7396	11 080	12 646	7755	5848
Melanoma of skin etc.	C43–C44	0	0	1	6	8	16	28	83	103	75	169	330	338	737	866	701	602	735
Prostate	C61	0	0	0	0	0	0	8	0	7	66	487	1844	4333	7797	10 615	9458	4869	3513
Bladder	C67	5	0	0	0	0	10	46	49	188	254	402	1051	1286	1506	2280	2461	1687	1394
Kidney, renal pelvis, ureter etc.	C64–C66 C68	16	23	0	0	1	23	29	85	262	306	649	1149	984	1565	1903	1462	765	536
Brain and nervous system	C70–C72	31	44	89	48	129	63	85	59	114	100	126	194	269	293	285	294	178	95
Thyroid	C73	0	0	0	18	36	58	81	105	65	123	215	361	247	245	221	217	106	28
Malignant lymphoma	C81–85 C96	9	43	22	77	48	69	141	228	264	381	597	674	1046	1302	1604	1521	892	749
Multiple myeloma	C88 C90	0	0	0	0	3	0	2	5	5	44	75	160	239	270	478	421	297	243
All leukaemias	C91–C95	162	84	48	64	112	82	156	149	117	164	275	365	439	671	777	750	478	307

Female

All sites (incl. CIS)	C00–C96 D00–D09	248	178	209	298	972	2407	4945	6920	10 446	14 101	18 686	26 896	28 609	30 500	35 638	36 211	31 284	36 692
All sites	C00–C96	248	178	209	285	596	1372	3149	5140	8819	12 773	17 301	25 607	27 125	29 124	34 121	34 887	30 392	36 040
Lip, oral cavity and pharynx	C00–C14	0	2	14	4	21	28	80	30	53	144	124	280	362	440	520	508	346	542
Esophagus	C15	0	0	0	0	0	0	4	2	10	81	147	258	279	328	329	378	395	467
Stomach	C16	0	0	0	4	0	41	281	399	781	1087	1644	2922	3333	4238	5397	5993	5080	5835
Colon	C18	0	0	17	0	7	25	117	173	356	703	1560	2313	3030	4278	4351	4720	4273	5146
Rectum	C19–C20	0	0	0	0	0	6	63	189	324	474	926	1361	1635	1773	1764	1761	1408	1833
Colon and rectum	C18–C20	0	0	17	0	7	31	180	362	680	1177	2486	3674	4665	6051	6115	6481	5681	6979
Liver	C22	23	0	0	0	4	5	30	18	81	62	250	707	1122	1806	2569	2787	2060	1941
Gallbladder etc.	C23–C24	0	0	0	0	5	0	6	24	30	68	209	262	512	801	1265	1553	1987	2677
Pancreas	C25	0	0	0	0	2	8	12	20	73	160	295	762	891	1171	1734	2006	1873	2684
Larynx	C32	0	0	0	0	0	0	0	0	7	14	4	14	31	11	23	10	43	57
Trachea, bronchus and lung	C33–C34	0	0	0	0	0	47	93	73	261	449	978	2186	2686	3021	3871	4159	3418	4375
Melanoma of skin etc.	C43–C44	0	0	17	7	26	17	71	22	81	99	91	193	290	303	492	689	755	1189
Breast (incl. CIS)	C50 D05	0	0	0	7	19	159	805	2092	4374	6139	6244	7245	6667	4930	4573	3352	2336	1753
Breast (only invasive)	C50	0	0	0	7	19	146	761	1973	4038	5732	5751	6903	6246	4629	4275	3179	2218	1706
Uterus (incl. CIS)	C53–C55 D06	0	0	6	28	413	1397	2412	2697	2455	2156	2446	3031	2157	1566	1589	1338	836	897
Uterus (only invasive)	C53–C55	0	0	6	19	64	402	726	1142	1309	1439	1966	2676	1915	1378	1464	1286	804	880
Cervix uteri	C53	0	0	0	19	50	334	553	908	920	704	857	1018	566	562	625	590	357	411
Corpus uteri	C54	0	0	6	0	14	67	171	226	361	709	1088	1579	1298	764	797	585	313	211
Ovary	C56	0	11	22	45	111	166	203	289	348	663	969	1186	985	805	757	629	513	602
Bladder	C67	0	0	0	0	0	13	9	23	17	55	143	156	242	293	553	621	748	985
Kidney, renal pelvis, ureter etc.	C64–C66 C68	15	35	2	10	9	29	17	32	83	93	281	433	474	521	812	725	662	651
Brain and nervous system	C70–C72	46	32	51	17	28	21	88	56	76	96	191	177	258	317	258	247	279	329
Thyroid	C73	0	0	4	22	110	200	279	313	451	626	672	935	857	767	663	522	361	311
Malignant lymphoma	C81–85 C96	5	14	14	84	32	125	58	94	158	217	382	724	676	812	1076	981	895	977
Multiple myeloma	C88 C90	0	0	0	0	0	0	0	4	13	55	44	183	224	269	330	293	400	356
All leukaemias	C91–C95	60	66	37	35	58	47	174	77	93	180	196	343	388	387	393	498	388	412

Table 3. Age-specific incidence rate per 100 000 population in Japan according to sex and primary site, 2005

Primary sites	ICD-10th	Age group (years)																	
		0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85+
Male																			
All sites (incl. CIS)	C00–C96, D00–D09	14.4	8.3	8.6	9.6	18.5	21.8	32.3	59.8	114.1	195.0	401.9	670.4	1135.1	1701.3	2414.8	3061.1	3291.8	3665.7
All sites	C00–C96	14.4	8.1	8.6	9.5	18.5	21.3	32.0	57.7	108.8	186.7	384.4	647.8	1098.2	1643.7	2344.5	2980.7	3221.9	3612.9
Lip, oral cavity and pharynx	C00–C14	0.0	0.2	0.5	0.1	1.0	0.9	1.2	1.6	3.0	6.7	12.4	22.2	27.8	29.3	34.9	46.7	40.4	40.9
Esophagus	C15	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.5	1.5	7.9	16.4	35.0	56.9	80.3	85.7	102.1	97.8	76.3
Stomach	C16	0.1	0.0	0.0	0.2	1.2	1.6	3.4	9.9	26.1	44.2	95.2	153.3	248.6	361.1	491.3	592.7	617.7	697.9
Colon	C18	0.0	0.0	0.0	0.2	0.0	1.5	2.3	7.1	11.2	17.0	40.7	64.1	111.6	167.8	224.6	277.1	325.4	349.2
Rectum	C19–C20	0.0	0.0	0.0	0.1	0.1	0.5	2.4	3.9	10.0	19.0	32.8	55.7	79.9	99.0	125.8	141.1	134.1	140.6
Colon and rectum	C18–C20	0.0	0.0	0.0	0.3	0.1	2.0	4.8	10.9	21.2	36.0	73.5	119.9	191.5	266.7	350.5	418.2	459.6	489.8
Liver	C22	0.5	0.0	0.0	0.0	0.2	0.5	1.1	3.6	6.7	13.0	34.7	55.0	99.0	136.1	192.1	209.0	200.2	177.7
Gallbladder etc.	C23–C24	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.9	0.6	2.0	6.4	9.5	21.1	35.0	50.7	84.6	121.1	156.9
Pancreas	C25	0.0	0.0	0.0	0.0	0.0	0.2	0.1	1.3	2.8	4.7	15.9	23.9	39.1	62.5	75.7	90.8	122.9	139.4
Larynx	C32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.7	3.7	8.9	17.4	19.5	18.1	32.0	28.1	24.5
Trachea, bronchus and lung	C33–C34	0.0	0.0	0.2	0.0	0.0	1.1	1.4	4.7	9.5	20.7	43.1	80.4	145.6	208.6	364.5	560.5	634.3	721.2
Melanoma of skin etc.	C43–C44	0.0	0.0	0.0	0.2	0.2	0.4	0.6	1.9	2.5	1.9	3.9	6.5	8.1	20.8	28.5	31.1	49.2	90.6
Prostate	C61	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	1.7	11.1	36.3	104.3	219.9	349.2	419.2	398.2	433.2
Bladder	C67	0.2	0.0	0.0	0.0	0.0	0.2	0.9	1.1	4.6	6.6	9.2	20.7	31.0	42.5	75.0	109.1	138.0	171.9
Kidney, renal pelvis, ureter etc.	C64–C66, C68	0.6	0.8	0.0	0.0	0.0	0.5	0.6	1.9	6.4	7.9	14.8	22.6	23.7	44.1	62.6	64.8	62.6	66.1
Brain and nervous system	C70–C72	1.1	1.4	2.9	1.4	3.4	1.5	1.7	1.3	2.8	2.6	2.9	3.8	6.5	8.3	9.4	13.0	14.6	11.7
Thyroid	C73	0.0	0.0	0.0	0.5	1.0	1.4	1.6	2.4	1.6	3.2	4.9	7.1	5.9	6.9	7.3	9.6	8.7	3.5
Malignant lymphoma	C81–85, C96	0.3	1.4	0.7	2.3	1.3	1.6	2.9	5.2	6.5	9.9	13.6	13.3	25.2	36.7	52.8	67.4	73.0	92.4
Multiple myeloma	C88, C90	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1.1	1.7	3.2	5.8	7.6	15.7	18.7	24.3	30.0
All leukaemias	C91–C95	5.7	2.8	1.6	1.9	3.0	2.0	3.2	3.4	2.9	4.2	6.3	7.2	10.6	18.9	25.6	33.2	39.1	37.9

Female

All sites (incl. CIS)	C00–C96, D00–D09	9.1	6.2	7.1	9.3	27.0	59.0	102.6	159.7	260.2	365.5	423.4	519.4	651.7	784.5	990.6	1204.4	1428.7	1734.2
All sites	C00–C96	9.1	6.2	7.1	8.9	16.6	33.6	65.3	118.6	219.6	331.0	392.0	494.6	617.9	749.2	948.4	1160.4	1387.9	1703.4
Lip, oral cavity and pharynx	C00–C14	0.0	0.1	0.5	0.1	0.6	0.7	1.7	0.7	1.3	3.7	2.8	5.4	8.2	11.3	14.5	16.9	15.8	25.6
Esophagus	C15	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	2.1	3.3	5.0	6.4	8.4	9.1	12.6	18.0	22.1
Stomach	C16	0.0	0.0	0.0	0.1	0.0	1.0	5.8	9.2	19.5	28.2	37.3	56.4	75.9	109.0	150.0	199.3	232.0	275.8
Colon	C18	0.0	0.0	0.6	0.0	0.2	0.6	2.4	4.0	8.9	18.2	35.3	44.7	69.0	110.0	120.9	157.0	195.1	243.2
Rectum	C19–C20	0.0	0.0	0.0	0.0	0.0	0.1	1.3	4.4	8.1	12.3	21.0	26.3	37.2	45.6	49.0	58.6	64.3	86.6
Colon and rectum	C18–C20	0.0	0.0	0.6	0.0	0.2	0.8	3.7	8.4	16.9	30.5	56.3	71.0	106.3	155.6	170.0	215.6	259.4	329.9
Liver	C22	0.8	0.0	0.0	0.0	0.1	0.1	0.6	0.4	2.0	1.6	5.7	13.7	25.6	46.5	71.4	92.7	94.1	91.7
Gallbladder etc.	C23–C24	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.6	0.7	1.8	4.7	5.1	11.7	20.6	35.2	51.7	90.7	126.5
Pancreas	C25	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.5	1.8	4.1	6.7	14.7	20.3	30.1	48.2	66.7	85.5	126.9
Larynx	C32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.1	0.3	0.7	0.3	0.6	0.3	2.0	2.7
Trachea, bronchus and lung	C33–C34	0.0	0.0	0.0	0.0	0.0	1.2	1.9	1.7	6.5	11.6	22.2	42.2	61.2	77.7	107.6	138.3	156.1	206.8
Melanoma of skin etc.	C43–C44	0.0	0.0	0.6	0.2	0.7	0.4	1.5	0.5	2.0	2.6	2.1	3.7	6.6	7.8	13.7	22.9	34.5	56.2
Breast (incl. CIS)	C50, D05	0.0	0.0	0.0	0.2	0.5	3.9	16.7	48.3	108.9	159.1	141.5	139.9	151.9	126.8	127.1	111.5	106.7	82.9
Breast (only invasive)	C50	0.0	0.0	0.0	0.2	0.5	3.6	15.8	45.5	100.6	148.6	130.3	133.3	142.3	119.1	118.8	105.7	101.3	80.6
Uterus (incl. CIS)	C53–C55, D06	0.0	0.0	0.2	0.9	11.5	34.2	50.0	62.2	61.1	55.9	55.4	58.5	49.1	40.3	44.2	44.5	38.2	42.4
Uterus (only invasive)	C53–C55	0.0	0.0	0.2	0.6	1.8	9.8	15.1	26.4	32.6	37.3	44.5	51.7	43.6	35.4	40.7	42.8	36.7	41.6
Cervix uteri	C53	0.0	0.0	0.0	0.6	1.4	8.2	11.5	21.0	22.9	18.2	19.4	19.7	12.9	14.5	17.4	19.6	16.3	19.4
Corpus uteri	C54	0.0	0.0	0.2	0.0	0.4	1.6	3.5	5.2	9.0	18.4	24.7	30.5	29.6	19.7	22.2	19.5	14.3	10.0
Ovary	C56	0.0	0.4	0.7	1.4	3.1	4.1	4.2	6.7	8.7	17.2	22.0	22.9	22.4	20.7	21.0	20.9	23.4	28.5
Bladder	C67	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.5	0.4	1.4	3.2	3.0	5.5	7.5	15.4	20.7	34.2	46.6
Kidney, renal pelvis, ureter etc.	C64–C66, C68	0.6	1.2	0.1	0.3	0.3	0.7	0.4	0.7	2.1	2.4	6.4	8.4	10.8	13.4	22.6	24.1	30.2	30.8
Brain and nervous system	C70–C72	1.7	1.1	1.7	0.5	0.8	0.5	1.8	1.3	1.9	2.5	4.3	3.4	5.9	8.2	7.2	8.2	12.7	15.5
Thyroid	C73	0.0	0.0	0.1	0.7	3.1	4.9	5.8	7.2	11.2	16.2	15.2	18.1	19.5	19.7	18.4	17.4	16.5	14.7
Malignant lymphoma	C81–C85, C96	0.2	0.5	0.5	2.6	0.9	3.1	1.2	2.2	3.9	5.6	8.7	14.0	15.4	20.9	29.9	32.6	40.9	46.2
Multiple myeloma	C88, C90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	1.4	1.0	3.5	5.1	6.9	9.2	9.7	18.3	16.8
All leukaemias	C91–C95	2.2	2.3	1.3	1.1	1.6	1.2	3.6	1.8	2.3	4.7	4.4	6.6	8.8	10.0	10.9	16.6	17.7	19.5

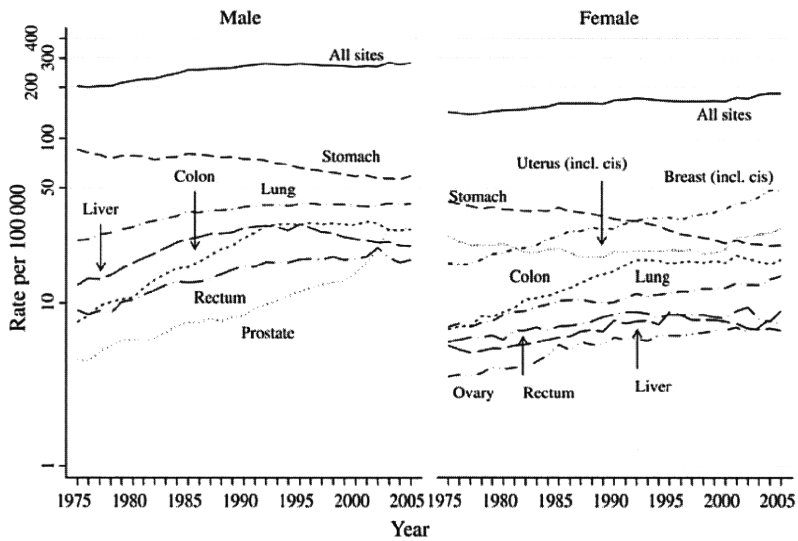

Figure 1. Trends of age-standardized cancer incidence rates for five major sites and specific sites for each sex (standard population: world population).

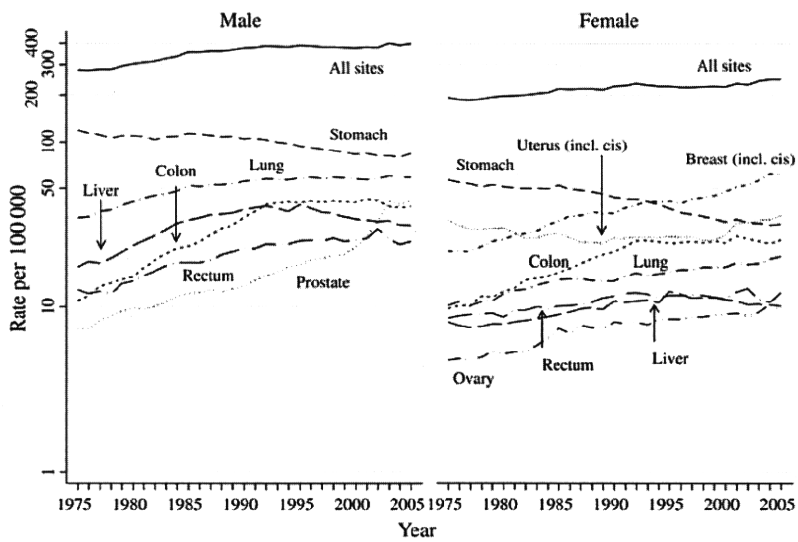

Figure 2. Trends of age-standardized cancer incidence rates for five major sites and specific sites for each sex (standard population: 1985 Japanese model population).

on the website (only available in Japanese, http://ganjoho.jp/professional/statistics/monita.html).

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Conflict of interest statement

None declared.

References

1. Marugame T, Kamo K, Katanoda K, Ajiki W, Sobue T. Cancer incidence and incidence rates in Japan in 2000: estimates based on data from 11 population-based cancer registries. *Jpn J Clin Oncol.* 2006;36:668–75.

2. Marugame T, Matsuda T, Kamo K, Katanoda K, Ajiki W, Sobue T. Cancer incidence and incidence rates in Japan in 2001 based on the data from 10 population-based cancer registries. *Jpn J Clin Oncol* 2007;37:884–91.
3. Matsuda T, Marugame T, Kamo K, Katanoda K, Ajiki W, Sobue T. Cancer incidence and incidence rates in Japan in 2002: based on data from 11 population-based cancer registries. *Jpn J Clin Oncol* 2008;38:641–8.
4. Matsuda T, Marugame T, Kamo K, Katanoda K, Ajiki W, Sobue T. Cancer incidence and incidence rates in Japan in 2003: based on data from 13 population-based cancer registries in the Monitoring of Cancer Incidence in Japan (MCIJ) Project. *Jpn J Clin Oncol* 2009;39:850–8.
5. Matsuda T, Marugame T, Kamo K, Katanoda K, Ajiki W, Sobue T. Cancer incidence and incidence rates in Japan in 2004: based on data from 14 population-based cancer registries in the Monitoring of Cancer Incidence in Japan (MCIJ) project. *Jpn J Clin Oncol* 2010; July 20 (Epub ahead of print).
6. The Research Group for Population-based Cancer Registration in Japan. Cancer incidence and incidence rates in Japan in 1988: estimates based on data from ten population-based Cancer Registries. *Jpn J Clin Oncol* 1994;24:299–304.
7. The Research Group for Population-based Cancer Registration in Japan. Cancer incidence in Japan 1985–89: re-estimation based on data from eight population-based cancer registries. *Jpn J Clin Oncol* 1998;28: 54–67.
8. The Research Group for Population-based Cancer Registration in Japan. Cancer incidence in Japan. In: Tajima K, Kuroishi T, Oshima A, editors. *Cancer Mortality and Morbidity Statistics—Japan and the World.* Tokyo: Japanese Scientific Societies Press 2004;95–130.

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Original Article

Population-based Survival of Cancer Patients Diagnosed Between 1993 and 1999 in Japan: A Chronological and International Comparative Study

Tomohiro Matsuda[1,*], Wakiko Ajiki[1], Tomomi Marugame[1], Akiko Ioka[2], Hideaki Tsukuma[2] and Tomotaka Sobue[1], Research Group of Population-Based Cancer Registries of Japan

[1]Population-Based Cancer Registry Section, Cancer Information Services and Surveillance Division, Center for Cancer Control and Information Services, National Cancer Center, Chuo-ku, Tokyo and [2]Department of Cancer Control and Statistics, Osaka Medical Center for Cancer and Cardiovascular Diseases, Osaka, Japan

*For reprints and all correspondence: Tomohiro Matsuda, Population-Based Cancer Registry Section, 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: tomatsud@ncc.go.jp

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Objective: The purpose of the present study was to collect data from population-based cancer registries and to calculate relative 5-year survival of cancer patients in Japan. We also sought to determine time trends and to compare the results with international studies.
Methods: We asked 11 population-based cancer registries to submit individual data for patients diagnosed from 1993 to 1999, together with data on outcome after 5 years. Although all these registries submitted data (491 772 cases), only six met the required standards for the quality of registration data and follow-up investigation. The relative 5-year survival calculated by pooling data from 151 061 cases from six registries was taken as the survival for cancer patients in Japan.
Results: Relative 5-year survival (1997–99) was 54.3% for all cancers (males: 50.0%, females: 59.8%). Survival figures for all sites changed slightly over the 7-year period, from 53.2% for the first 4 years of the study (1993–96) to 54.3% for the last 3 years (1997–99), however, a major improvement was observed in several primary sites. Some overall survival was lower in Japan than in the USA, but similar to that in European countries. Specifically, survival for uterine cancer, prostate cancer, testis cancer, lymphoma and leukemia was much lower in Japan than in other countries. However, survival was better in Japan mainly for cancers of the esophagus, stomach, colon, liver and gallbladder.
Conclusion: The study suggests an improvement in cancer survival in several primary sites in Japan, which is consistent with the development of treatments and early detection.

Key words: epidemiology/public health – prognostic factors – epidemiol-prevention

INTRODUCTION

Cancer survival, as assessed based on population-based cancer registries, is a valuable medical indicator to evaluate the progress of cancer control in a country or region. Precise population-based cancer survival is a comprehensive, practical and timely index for cancer control in a country. Use of relative 5-year survival statistics is useful to evaluate therapeutic effect in cancer incidence/mortality trends in real time. Cancer survival has also been shown to be powerful when comparing survival between sex, age groups and socioeconomic groups or between geographic areas where incidence or death due to other causes may differ.

However, this information is not often available because of legislative, financial and technical difficulties in following-up patients, even in population-based cancer registries in developed nations.

Clinical research groups frequently publish hospital-based survival rates for cancer patients at specific medical facilities (1–3); however, these data do not provide useful information to political planners because of inevitable recruitment bias. Population-based survival is a thus prerequisite for designing public health projects and evaluating the efficacy of cancer prevention, screening and treatment.

In 1998, we proposed standard methods which required checking of vital status of patients by inquiring to the resident registration 5 years after diagnosis (4). We reported relative 5-year survival based on these methods for stomach, lung and breast cancer diagnosed from 1985 to 1989, using data from cancer registries of Yamagata, Fukui and Osaka Prefectures (5), which had collected data satisfying the methodological criteria. In 2001, we collected, from 12 registries belonging to the study group, individual data from all cancer patients (for all sites) diagnosed in 1993 for whom outcome information after 5 years was available. From this data we attempted to produce a nationwide relative 5-year survival according to standard methods (6). This nationwide survival, however, could not be completed because there were differences in the quality of registration and assessment methods of outcome among the 12 registries. A population-based survival was therefore not published in Japan until 2006 (7). This first population-based study reported that relative 5-year survival calculated by pooling 279 000 data from 7 registries was 49.2% for males and 59.4% for females.

The aims of the study were first to calculate the most recent relative 5-year survival of cancer patients in Japan, and second to observe changes in survival by comparing the data between two observation periods, 1993–96 and 1997–99, and by comparison with the results of international studies.

PATIENTS AND METHODS

Eleven among 15 registries (Miyagi, Yamagata, Niigata, Chiba, Kanagawa, Fukui, Aichi, Shiga, Osaka, Tottori, Okayama, Saga, Nagasaki, Kumamoto and Okinawa) submitted individual data (a total of 491 772 cases) to the survival study. These 15 registries were selected because they had relatively high-quality data tracing the 5-year outcome of patients diagnosed from 1993 to 1999. They had also participated in the Monitoring of Cancer Incidence in Japan (MCIJ) project for 2002 incident cases (8). We requested 11 population-based cancer registries to submit patient data for cancers at all sites, diagnosed from 1993 to 1999, including information on outcome after 5 years. We pooled cancer registry data that met standards of data quality in terms of both registration and outcome assessment.

Quality Criteria for Area Selection

The quality criteria were based on the standards adopted in the above-mentioned MCIJ project: DCO% (death certificate only: proportion of patients for whom the death certificate provides the only notification to the registry) $<25\%$ or DCN% (death certificate notification: proportion of patients for whom the death certificate provides the first notification to the registry) $<30\%$, and IM ratio (incidence to mortality ratio) less than 1.5 (8). Among the 11 registries, six (Miyagi, Yamagata, Niigata, Fukui, Osaka and Nagasaki) met the required standards for the quality of registration and outcome assessment. According to the data provided by these registries, we calculated survival rates and considered them to be a nationwide index.

As far as the quality of outcome assessment was concerned, we set two criteria relating to follow-up methods. For registries checking survival of patients by referring to resident registries (active follow-up; Yamagata, Fukui and Osaka), we specified that the proportion of outcome-unknown cases 5 years after diagnosis should be $<5\%$. For registries having no confirmation of survival 5 years after diagnosis (passive follow-up; Miyagi, Niigata and Nagasaki), we specified that information on personal identification including names would be computerized in order to collate the registered patients with death information with high accuracy. Registries that met these criteria were therefore guaranteed to have sufficiently accurate information about death.

Survival Calculation

Referring to other studies, since 1996 the research group has set standardized methods of calculating survival in Japan through the collaborative study of population-based cancer registries. The method of calculating survival is mainly based on the EUROCARE study (9). In concrete terms, we excluded DCO cases, cancers *in situ* and mucosal cancers of the large bowel from the analysis. In the case of multiple cancers, only the first-diagnosed tumor was analyzed.

This study calculated the survival for cancers including followed-back cases from DCN (Subjects 1) and excluding these cases (Subjects 2). The former method was that used in the EUROCARE study, and is suitable for international comparison of survival based on population-based cancer registries. The latter should instead be utilized for domestic comparison of survival in Japan where some registries do not conduct follow-back inquiries to medical institutions for DCN cases, according to death certificate information.

Survival for Subjects 2 is generally better than that for Subjects 1 because the latter include cases regarded as incident according to death information. Given the high proportion of incident cases not reported by medical facilities but registered on the basis of death certificates, the survival calculated for Subjects 1 may be underestimated. In contrast, it is also possible for survival to be overestimated in Subjects 2. In Japan, each population-based registry decides

whether to apply active follow-up; consequently, the survival of Subjects 2 would be better than that of Subjects 1. In this study, we will regard the survival calculated for Subjects 2 as that of cancer patients in Japan.

Cumulative 5-year survivals were calculated starting from the date of diagnosis. Expected survivals were calculated using the cohort survival table based on life tables of the Japanese population and then using the survival probability in the general population similar to the patients in sex, birth year and age. The former were divided by the latter to obtain relative 5-year survivals.

If vital status was unknown at 5 years after diagnosis, cases were dealt with as alive at the last contact date (5). However, for the three registries that had not checked the survival of patients by referring to the resident registry, we regarded all cases whose death was not confirmed as being alive until 5 years, and survival was calculated on this basis.

RESULTS

Survival Data Quality

Table 1 shows the number of incident cases, validity indices of registration, and the number of study subjects for survival analysis, for each registry in the two studies. In 1997–99 there were 221 080 incident cases, and the following cases were excluded from the survival analysis: DCO (36 939 cases, 16.7% of the total), subsequent primary tumors (17 814 cases, 8.1% of the total), non-malignant tumors (565 cases, 0.3% of the total), and *in situ* cancers (3 264 cases, 1.5% of the total). In addition, after excluding patients with unknown age at diagnosis and those over 100 years old, we considered the rest (164 738 cases, 74.5% of the total) as Subjects 1. Moreover, for DCN cases, additional cancer reports were requested in Yamagata, Fukui and Osaka Prefectures, and the registry records of cases originating from death information were distinguished in Miyagi Prefecture. The number of cases in which we traced the death information to incidence was 13 677, 8.3% of the total. The number of final analysis subjects (Subjects 2) excluding these cases was 151 061, corresponding to 68.3% of the total.

Table 2 shows the vital status at 5 years from diagnosis. In the Miyagi, Yamagata and Niigata Cancer Registries, in which the vital status of patients was checked after 5 years by referring to resident registries, the proportion of cases with unknown vital status was 2.0% among these three registries. Survival rate varied from 38.0 to 45.8%.

Table 1. Number of incident cases, validity indices of registration and number of study subjects for survival calculations, according to registry—cases diagnosed in 1993–96 (the previous study) and in 1997–99

Observation period	Registry	*n*	DCO		Subsequent primary		Non-malignant tumors		CIS		Subjects 1		Follow-back cases		Subjects 2	
			n	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[b]	*n*	%[a]
1993–96	Miyagi	37 194	5709	15.3	4359	11.7	127	0.3	919	2.5	26 832	72.1	183	0.7	26 649	71.6
	Yamagata	24 416	2546	10.4	1211	5.0	0	0.0	285	1.2	20 406	83.6	2531	12.4	17 875	73.2
	Niigata	44 818	10 843	24.2	1621	3.6	5	0.0	495	1.1	31 867	71.1	–	–	31 867	71.1
	Fukui	13 886	575	4.1	797	5.7	3	0.0	153	1.1	12 395	89.3	1586	12.8	10 809	77.8
	Osaka	120 040	23 386	19.5	7488	6.2	360	0.3	1507	1.3	88 551	73.8	13 411	15.1	75 140	62.6
	Nagasaki	30 338	2790	9.2	2663	8.8	0	0.0	601	2.0	24 576	81.0	–	–	24 576	81.0
	Total	270 692	45 849	16.9	18 139	6.7	495	0.2	3960	1.5	204 627	75.6	17 711	8.7	186 916	69.1
1997–99	Miyagi	32 439	4232	13.0	4015	12.4	181	0.6	767	2.4	23 741	73.2	844	3.6	22 897	70.6
	Yamagata	19 248	1949	10.1	1202	6.2	1	0.0	195	1.0	15 953	82.9	1709	10.7	14 244	74.0
	Niigata	35 908	8737	24.3	1958	5.5	18	0.1	387	1.1	24 824	69.1	–	–	24 824	69.1
	Fukui	11 559	562	4.9	922	8.0	14	0.1	132	1.1	9974	86.3	1016	10.2	8958	77.5
	Osaka	97 641	19 268	19.7	7050	7.2	351	0.4	1223	1.3	71 093	72.8	10 108	14.2	60 985	62.5
	Nagasaki	24 285	2191	9.0	2667	11.0	0	0.0	560	2.3	19 153	78.9	–	–	19 153	78.9
	Total	221 080	36 939	16.7	17 814	8.1	565	0.3	3264	1.5	164 738	74.5	13 677	8.3	151 061	68.3
Total		491 772	82 788	16.8	35 953	7.3	1060	0.2	7224	1.5	369 365	75.1	31 388	8.5	337 977	68.7

DCO, Death certificate only cases; Follow-back cases: cases notified by death certificates require follow-back to obtain their clinical information.
Subjects 1: including followed-back cases from DCN; Subject 2: excluding followed-back cases.
[a]Proportion of total cases.
[b]Proportion of Subject 1 cases.

Table 2. Vital status at 5 years from diagnosis

Registry	Subjects 1	Dead		Alive		Unknown		Survival proportion (excl. unknown cases), %
		n	%[a]	*n*	%[a]	*n*	%[a]	
1993–96								
Active follow-up								
Yamagata	20 406	11 041	54.1	9219	45.2	146	0.7	45.5
Fukui	12 395	6905	55.7	5111	41.2	379	3.1	42.5
Osaka	88 551	54 229	61.2	32 447	36.6	1875	2.1	37.4
Total	121 352	72 175	59.5	46 777	38.5	2400	2.0	43.9
Passive follow-up								
Niigata	31 867	15 183	47.6	16 684	52.4	–	–	–
Miyagi	26 832	12 811	47.7	14 021	52.3	–	–	–
Nagasaki	24 576	13 180	53.6	11 396	46.4	–	–	–
Total	204 627	113 349	55.4	88 878	43.4	–	–	–
1997–99								
Active follow-up								
Yamagata	15 953	8563	53.7	7231	45.3	159	1.0	45.8
Fukui	9974	5377	53.9	4238	42.5	359	3.6	44.1
Osaka	71 093	43 135	60.7	26 399	37.1	1559	2.2	38.0
Total	97 020	57 075	58.8	37 868	39.0	2077	2.1	44.8
Passive follow-up								
Niigata	24 824	11 541	46.5	13 283	53.5	–	–	–
Miyagi	23 741	11 256	47.4	12 485	52.6	–	–	–
Nagasaki	19 153	9885	51.6	9268	48.4	–	–	–
Total	164 738	89 757	54.5	72 904	44.3	–	–	–
Total	369 365	203 106	55.0	161 782	43.8	–	–	–

[a]Proportion of total cases.

Survival by Age and Sex

Table 3 shows 5-year relative survival rate and standard error according to the primary site and sex, excluding the follow-back cases (i.e. in Subjects 2). The 5-year relative survival was 53.2% for all cancers diagnosed in 1993–96 (M: 48.9%, F: 59.0%), while that for 1997–99 was 54.3% (M: 50.0%, F: 59.8%).

When all sites were considered together, females had a higher survival than males (M: 50.0%, F: 59.8%). This tendency was evident for lip, oral cavity and pharynx (M: 48.3% vs. F: 63.0%) and lung cancer (M: 22.4% vs. F: 33.5%). In contrast, females had a lower survival than males in for cancers of the larynx (M: 77.0% vs. F: 64.4%) and bladder (M: 78.6% vs. F: 69.8%).

The relative 5-year survivals for all sites decreased markedly in the elderly. In males, this difference was pronounced for cancers of the lip, oral cavity and pharynx, bladder and thyroid, as well as in malignant lymphoma and all leukemias. For women, there was a marked age-related decrease in survival for cancers of the lip, oral cavity and pharynx and uterus (cervix and corpus), as well as malignant lymphoma, multiple myeloma and all leukemias (Fig. 1).

Survival and Time Trends for Survival by Primary Site

Survival probabilities for cancers of the cervix, prostate, larynx, bladder, corpus uteri, female breast, testis and thyroid ranged from 71.5 to 92.4%; those for ovary, mouth, oral cavity and pharynx, stomach, rectum and anus, and colon ranged from 52.0 to 68.9%; those for pancreas, gallbladder, liver, lung, multiple myeloma, esophagus, all leukemias and malignant lymphoma ranged from 6.7 to 49.9% (Table 3).

Survival figures for all sites improved significantly over the 7-year period, increasing from 53.2% for the first observation period (1993–96) to 54.3% in the second (1997–99) (Table 3). Proportion of localized tumor at diagnosis increased; 43.0–52.0% for prostate, 5.4–10.1% for multiple myeloma, 25.0–28.6% for lung, 26.7–29.3 for malignant lymphoma, 43.3–45.5% for lip, oral cavity and pharynx,

Table 3. Relative 5-year survival by sex for selected sites of cancer diagnosed in 1993–96 and in 1997–99 (Subjects 2)

Primary sites	Male			Female			Total		
	n	Relative survival rate		*n*	Relative survival rate		*n*	Relative survival rate	
		%	SE		%	SE		%	SE
1993–96									
All sites (C00–C96)	106 022	48.9	0.2	77 473	59.0	0.2	183 495	53.2	0.1
Lip, oral cavity and pharynx (C00–C14)	2535	48.6	1.1	1022	64.7	1.7	3557	53.2	0.9
Esophagus (C15)	4401	25.7	0.7	843	33.1	1.7	5244	26.9	0.7
Stomach (C16)	29 318	62.1	0.3	14 817	60.4	0.5	44 135	61.6	0.3
Colon (C18)	10 542	71.3	0.6	8609	66.1	0.6	19 151	68.9	0.4
Rectum and anus (C19–C21)	7089	65.0	0.7	4316	63.9	0.8	11 405	64.6	0.5
Liver (C22)	9958	21.0	0.4	3619	21.8	0.7	13 577	21.2	0.4
Gallbladder etc. (C23–C24)	2475	19.0	0.9	2962	20.1	0.8	5437	19.6	0.6
Pancreas (C25)	2855	7.0	0.5	2205	5.9	0.5	5060	6.5	0.4
Larynx (C32)	1570	78.2	1.4	90	75.9	6.3	1660	78.1	1.4
Trachea, bronchus and lung (C33–C34)	15 124	20.8	0.4	5618	27.1	0.6	20 742	22.5	0.3
Female breast (C50)				14 094	84.4	0.4	14 094	84.4	0.4
Uterus (C53–C55)				5332	74.4	0.7	5332	74.4	0.7
Cervix uteri (C53)				3472	73.4	0.8	3472	73.4	0.8
Corpus uteri (C54)				1688	79.5	1.1	1688	79.5	1.1
Ovary (C56)				2116	49.4	1.1	2116	49.4	1.1
Prostate (C61)	4220	66.8	1.0				4220	66.8	1.0
Testis (C63)	505	89.6	1.6				505	89.6	1.6
Bladder (C67)	3481	80.0	1.0	1049	70.6	1.8	4530	77.8	0.9
Thyroid (C73)	541	86.3	2.1	2483	93.2	0.7	3024	92.0	0.7
Malignant lymphoma (C81–85, C96)	2349	46.3	1.1	1800	51.4	1.3	4149	48.5	0.9
Multiple myeloma (C88, C90)	508	29.3	2.2	446	30.9	2.3	954	30.0	1.6
All leukemias (C91–C95)	1686	31.7	1.2	1234	33.2	1.4	2920	32.3	0.9
1997–99									
All sites (C00–C96)	84 851	50.0	0.2↑**	62 860	59.8	0.2↑**	147 711	54.3	0.1↑**
Lip, oral cavity and pharynx (C00–C14)	1853	48.3	1.3	854	63.0	1.9	2707	52.9	1.1
Esophagus (C15)	3834	30.7	0.8↑**	643	37.3	2.0	4477	31.6	0.8↑**
Stomach (C16)	2190	62.6	0.4	10 485	61.2	0.5	32 375	62.1	0.3
Colon (C18)	8370	71.0	0.6	7106	66.4	0.7	15 476	68.9	0.5
Rectum and anus (C19–C21)	5797	65.7	0.8	3475	64.5	0.9	9272	65.2	0.6
Liver (C22)	7689	23.7	0.5↑**	3118	21.8	0.8	10 807	23.1	0.4↑**
Gallbladder etc. (C23–C24)	1884	21.8	1.1↑*	2430	18.9	0.8	4314	20.2	0.7
Pancreas (C25)	2386	6.2	0.5	1900	7.3	0.6	4286	6.7	0.4
Larynx (C32)	1130	77.0	1.7	78	64.4	6.6	1208	76.1	1.6
Trachea, bronchus and lung (C33–C34)	12 737	22.4	0.4↑**	4963	33.5	0.7↑**	17 700	25.6	0.4↑**
Female breast (C50)				12 334	85.5	0.4	12 334	85.5	0.4
Uterus (C53–C55)				3995	72.5	0.8	3995	72.5	0.8
Cervix uteri (C53)				2244	71.5	1.1	2244	71.5	1.1

Continued

Table 3. *Continued*

Primary sites	Male			Female			Total		
	n	Relative survival rate		*n*	Relative survival rate		*n*	Relative survival rate	
		%	SE		%	SE		%	SE
Corpus uteri (C54)				1571	76.8	1.2	1571	76.8	1.2
Ovary (C56)				1800	52.0	1.2	1800	52.0	1.2
Prostate (C61)	4508	75.5	1.0↑**				4508	75.5	1.0↑**
Testis (C63)	369	92.0	1.9				369	92.0	1.9
Bladder (C67)	2824	78.6	1.1	870	69.8	2.0	3694	76.5	1.0
Thyroid (C73)	437	87.6	2.3	1986	93.5	0.8	2423	92.4	0.7
Malignant lymphoma (C81–85, C96)	1949	46.6	1.3	1473	54.2	1.4	3422	49.9	0.9
Multiple myeloma (C88, C90)	422	31.5	2.5	403	28.1	2.4	825	29.8	1.7
All leukemias (C91–C95)	1242	32.2	1.4	986	33.8	1.6	2228	32.9	1.0

↑Improved significantly between the two observation periods $^{**}P < 0.01$, $^{*}P < 0.05$.

31.6–33.5% for esophagus, 34.5–36.4% for ovary, 70.1–71.7% for liver and 55.6–57.2% for female breast. Accordingly survival also improved significantly for cancers of the prostate (by 8.7 points), esophagus (by 4.7 points), lung (by 3.1 points) and liver (by 1.9 points).

Survival and Time Trends for Survival by Extent of Disease

Table 4 shows observed and relative 5-year survival by extent of disease at diagnosis. Relative survival for all sites (C00–C96) was 85.2% for localized tumors, 43.7% for those with regional lymph node or direct invasion to the adjacent tissue/organ and 10.1% for those with distant metastasis. When all sites were considered together, improvement in survival was found only for localized tumors; survival rate increased from 84.6 to 85.2% ($P < 0.05$).

Among localized tumors, survival improvement between the two periods was observed for the esophagus, liver, lung and female breast; among tumors with regional lymph node or direct invasion to the adjacent tissue/organ, improvement was seen for the pancreas, lung, prostate and testis. No improvement was observed in distant metastatic tumor cases.

In contrast, survival deteriorated significantly between the two observation periods for localized bladder cancer, laryngeal cancer with regional lymph node or adjacent organ metastasis, and gallbladder cancer with distant metastasis.

Comparison with International Data

Table 5 shows relative 5-year survivals in the current study, SEER study (10) and EUROCARE4 study (11). Compared with the American data (SEER study), overall all-age survival was lower in Japan (64.9–54.3%); however, age-standardized survival in Japan was similar to that in European countries (53.3–51.9%). In particular, the survivals for Japanese patients with uterine cancer, prostate cancer, testicular cancer, lymphoma and leukemia were much lower than for their American counterparts. Survival in Japan was better than in Europe or the USA mainly for cancers of the digestive and hepatobiliary organs, such as the esophagus, stomach, colon, liver and gallbladder.

DISCUSSION

Survival in Japan

On the basis of the data from six population-based cancer registries in Japan that met standards for data quality in terms of both registration and outcome assessment, we calculated the latest relative 5-year survival for major cancers.

Age differences were observed in survival when all sites were considered together and in some specific primary sites. Ioka et al. (12) found that advanced cervical cancers leading to poor survival are common in older people. Otherwise, this may be explained by histological differences or simply physical decline in older patients. Farley et al. (13) reported a similar decreasing survival with age in their study of uterine cancer. Studies of leukemia (14) and bladder cancer (15) also show similar effects of age.

Sex differences in survival for cancers at two primary sites, the larynx and lung, might be caused by biological differences between the two sexes and diagnostic circumstances. These differences could relate to smoking behavior in the two sexes, even for cancers of the same histology. Nordquist et al. (16) found differences in survival according to the smoking status of patients with adenocarcinoma of the lung. Another study showed that the survival of bladder

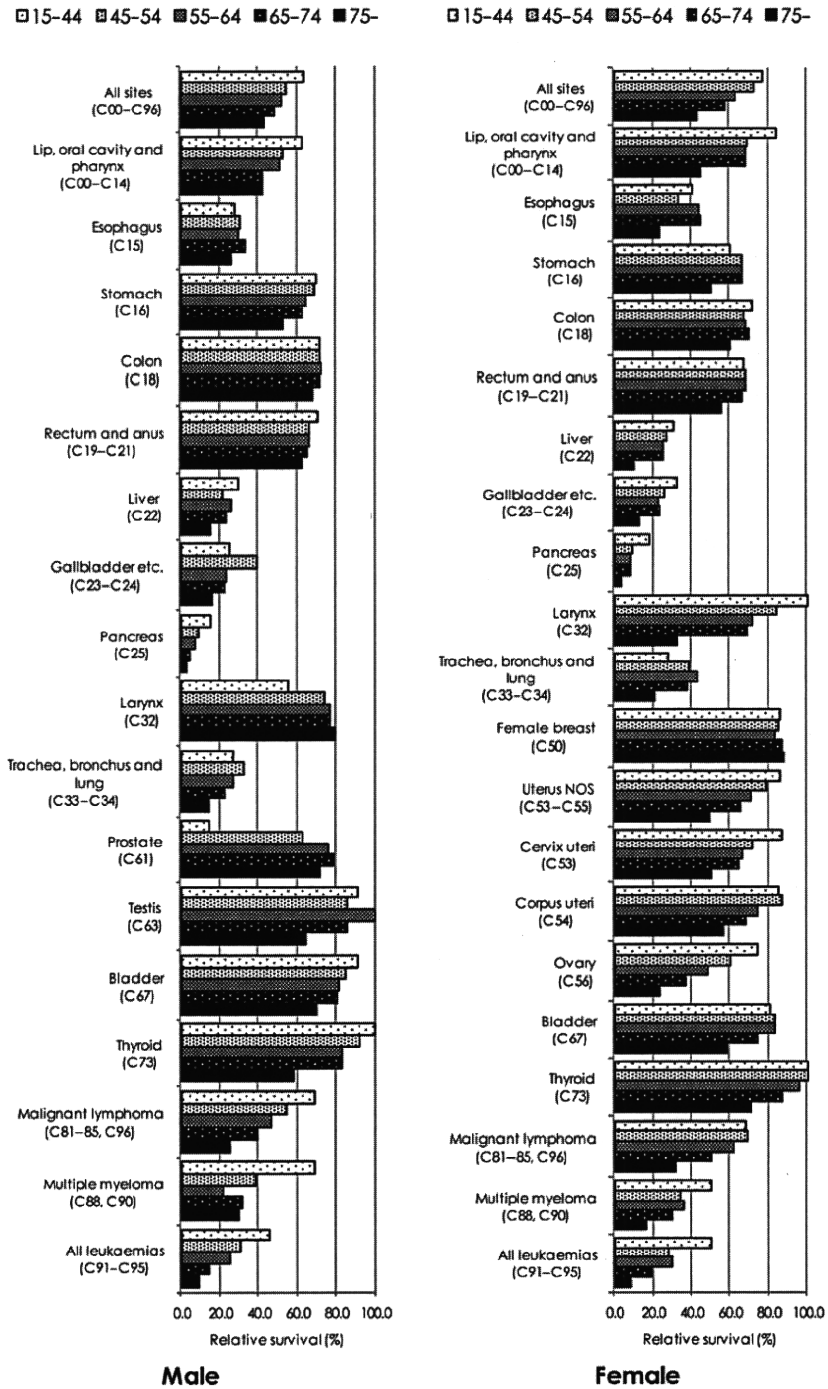

Figure 1. Relative 5-year survival for major sites of cancer by sex and age at diagnosis (1997–99, Subject 2).

cancer patients varies according to current smoking, age and gender, in addition to a latent promoter hypermethylation (17). Bladder cancer is often at a more advanced tumor stage at diagnosis in women than in men.

Comparison Between the Two Periods and with the Results of International Studies

Overall chronological improvement of survival in several primary sites was observed, confirming the findings of a

Table 4. Relative 5-year survival for major sites of cancer by extent of tumor at diagnosis (Subjects 2)

Primary sites	Localized		Regional lymph node metastases, adjacent organ metastases		Distant metastasis	
	%	SE	%	SE	%	SE
1993–96						
All sites (C00–C96)	84.6	0.2	43.2	0.2	10.3	0.2
Lip, oral cavity and pharynx (C00–C14)	75.0	1.5	39.4	1.4	16.5	2.8
Esophagus (C15)	55.2	1.6	19.1	0.9	3.7	0.6
Stomach (C16)	94.4	0.3	40.2	0.5	3.1	0.2
Colon (C18)	96.6	0.5	64.8	0.8	8.2	0.5
Rectum and anus (C19–C21)	93.0	0.6	55.3	0.9	8.1	0.7
Liver (C22)	30.3	0.6	8.6	0.8	4.0	0.5
Gallbladder etc. (C23–C24)	61.5	1.8	12.6	0.8	1.6	0.3
Pancreas (C25)	37.1	2.5	4.5	0.5	1.1	0.2
Larynx (C32)	89.3	1.6	51.8	3.2	14.2	5.4
Trachea, bronchus and lung (C33–C34)	65.8	0.9	16.0	0.5	2.5	0.2
Female breast (C50)	96.6	0.3	78.3	0.7	25.3	1.7
Uterus (C53–C55)	93.1	0.6	54.1	1.4	15.2	2.0
Cervix uteri (C53)	93.6	0.8	52.8	1.6	9.8	2.1
Corpus uteri (C54)	92.9	1.0	63.4	3.1	22.7	3.7
Ovary (C56)	89.6	1.6	40.5	2.0	15.4	1.6
Prostate (C61)	96.5	1.7	71.0	2.9	35.2	1.7
Testis (C63)	99.5	1.1	86.3	6.3	60.9	6.1
Bladder (C67)	91.4	1.0	35.1	2.7	7.6	1.9
Thyroid (C73)	98.6	0.8	94.0	0.9	40.7	4.3
Malignant lymphoma (C81–85, C96)	75.3	2.0	55.4	2.4	36.2	1.4
Multiple myeloma (C88, C90)	56.4	11.5	55.0	15.6	25.3	2.2
All leukemias (C91–C95)	–	–	–	–	–	–
1997–99						
All sites (C00–C96)	85.2	0.2↑*	43.7	0.3	10.1	0.2
Lip, oral cavity and pharynx (C00–C14)	76.1	1.7	39.2	1.6	12.7	2.9
Esophagus (C15)	64.9	1.6↑**	21.0	1.0	4.8	0.8
Stomach (C16)	95.2	0.3	39.8	0.6	2.9	0.3
Colon (C18)	95.7	0.5	65.0	0.9	9.3	0.6
Rectum and anus (C19–C21)	94.0	0.7	56.4	1.0	9.7	0.8
Liver (C22)	33.2	0.7↑**	10.4	0.9	3.2	0.5
Gallbladder etc. (C23–C24)	57.4	2.0	14.0	0.9	0.8	0.2↓*
Pancreas (C25)	34.7	2.7	6.1	0.6↑*	1.0	0.2
Larynx (C32)	90.0	1.9	37.5	3.5↓**	5.7	2.7
Trachea, bronchus and lung (C33–C34)	68.7	0.9↑*	18.6	0.6↑**	2.8	0.2
Female breast (C50)	97.7	0.3↑**	78.4	0.7	27.6	1.8
Uterus (C53–C55)	92.2	0.7	52.4	1.6	12.8	2.0
Cervix uteri (C53)	92.3	1.1	53.1	2.0	10.2	2.4
Corpus uteri (C54)	92.4	1.1	53.7	3.1↓*	17.2	3.2

Continued

Table 4. *Continued*

Primary sites	Localized		Regional lymph node metastases, adjacent organ metastases		Distant metastasis	
	%	SE	%	SE	%	SE
Ovary (C56)	86.0	1.8	43.6	2.1	20.3	2.1
Prostate (C61)	97.6	1.3	79.2	2.9↑*	39.6	1.8
Testis (C63)	97.8	1.8	100.0	0.0↑*	70.7	6.3
Bladder (C67)	88.1	1.1↓*	34.3	2.8	8.8	2.4
Thyroid (C73)	99.6	0.8	93.6	1.1	41.7	4.9
Malignant lymphoma (C81–85, C96)	79.8	2.1	58.4	2.7	34.1	1.6
Multiple myeloma (C88, C90)	51.2	10.2	52.7	15.7	24.4	2.8
All leukemias (C91–C95)	–	–	–	–	–	–

↑ improved significantly between the two observation periods $^{**}P < 0.01$, $^{*}P < 0.05$.
↓ deteriorated significantly between the two observation periods $^{**}P < 0.01$, $^{*}P < 0.05$.

regional study (18). Unfortunately, no change was seen in survival of cancers with distant metastases.

There were particularly marked improvements in survival for cancers of the esophagus, liver and female breast, which might be mainly due to diffusion of organized screening programs in the society or development of early detection systems in cases of opportunistic screening (19–22). Treatment has also evolved during these two observational periods. Yamanaka et al. (23) reported, for example, that the establishment of indication criteria for hepatectomy and the introduction of multimodal treatment for recurrence were contributory factors. Lung cancer patients, particularly those with early stage disease, also benefit from improvements in surgical technique (24). The increase in breast cancer survival likely results from development of new treatments. The breast conserving treatment with or without axillary dissection has been developed and replaced Halsted radical mastectomy in early 1990s in Japan. At the same time, endocrine therapy has progressed remarkably with acceptance of tamoxifen use in 1981. Since then LHRH agonist and aromatase inhibitors were approved one after another in the mid-1990s, and effective chemotherapy regimens in premenopausal women have also been developed: the majority of the university hospitals and clinics employed these new treatment strategies. We have to be cautious when considering prostate cancer survival because the early detection of micro tumors by PSA screening has been evident for more than a decade. However, considering that survival was particularly improved for cases with metastasis to regional lymph nodes or adjacent organs, the introduction of more effective radiation therapy might have contributed to the survival of older patients with prostate cancer (25).

We found that the overall survival of cancer patients in Japan is comparable with that in Europe (51.9%), although survival for some cancer types, particularly prostate cancer, lymphoma and leukemia, is much lower than in these Western countries. In contrast, the overall survival in the USA was much higher than Japan. This is probably due to the large difference of weights on breast and prostate cancer in cancer incidence. Survival for digestive organ and hepatobiliary cancers was better in Japan than in Western countries. For specific types of cancer, greater survival in a particular country tends to be correlated with higher incidence in that country (8). A high survival rate might result from greater surgical volume for these primary sites (26). In other words, compared with their Western counterparts, Japanese oncologists are usually more aware of digestive organ and hepatobiliary cancers and have greater experience in treatment of these cancers. Conversely, tumors that are sensitive to chemotherapy seem to be treated less effectively by Japanese oncologists. This slow progress in chemo-sensitive malignancies may demonstrate weaknesses of the system of oncology in Japan; serious shortage of oncologists specialized in chemotherapy and less centralized primary cancer treatment.

Changes over time in Japan were similar to those in the international studies examined. For example, considering changes in lung cancer and breast cancer, the time trends identified in Japan were very similar to those seen when comparing EUROCARE 3 and EUROCARE 4 (27).

Limitations

To perform survival analyses in Japan, it is a priority to improve the quality of cancer registry data, because the high proportion of patients not registered will diminish the accuracy of survival estimates according to international criteria (28). In this study, we required each registry to meet the necessary standards for participating in nationwide estimates of incidence (8). It would be reasonable to assume, therefore,

Table 5. Comparison of the survival between the SEER (96-03), the EUROCARE 4 and the present study

Primary sites	Present study (Subjects 2) 1997–99		SEER 1996–2003	EUROCARE4 1995–99
	All ages	Age standardized rate	All ages	Age standardized rate
All sites (C00–C96)	54.3	53.3	64.9	51.9
Lip, oral cavity and pharynx (C00–C14)	52.9	51.6	59.1	–
Esophagus (C15)	31.6	30.6	15.6	12.3
Stomach (C16)	62.1	61.4	24.3	24.1
Colon (C18)	68.9	68.7	63.5	53.9
Rectum and anus (C19–C21)	65.2	64.7	65.0	53.5
Liver (C22)	23.1	22.0	10.8	8.6
Gallbladder etc. (C23–C24)	20.2	22.1	15.1[a]; 18.6[b]	14.1
Pancreas (C25)	6.7	7.2	5.0	5.5
Larynx (C32)	76.1	75.2	62.9	63.1
Trachea, bronchus and lung (C33–C34)	25.6	25.8	15.0	12.6
Female breast (C50)	85.5	86.1	88.6	81.1
Cervix uteri (C53)	71.5	70.6	71.6	66.5
Corpus uteri (C54)	76.8	69.9	83.9	78.3
Ovary (C56)	52.0	41.3	44.9	41.6
Prostate (C61)	75.5	69.7	98.1	77.0
Testis (C63)	92.0	88.4	98.4	93.8
Bladder (C67)	76.5	77.5	79.5	65.8
Thyroid (C73)	92.4	91.2	93.9	86.5
Malignant lymphoma (C81–85, C96)	49.9	45.6	66.8	–
Hodgkin's lymphoma	68.3	71.8	84.9	83.0
Non-Hodgkin's lymphoma	49.1	45.5	63.4	54.6
Multiple myeloma (C88, C90)	29.8	30.7	33.7	34.4
All leukemias (C91–C95)	32.9	20.6	49.6	–
Acute lymphocytic leukemia	50.0	25.3	64.0	30.0
Acute myelogenous leukemia	26.6	17.1	21.2	19.0
Chronic myelogenous leukemia	44.0	32.5	47.5	39.5

[a]Gallbladder.
[b]Intrahepatic bile duct.

that the current study has been conducted on the basis of fairly accurate data from population-based cancer registries.

In the three prefectures where the vital status of patients was checked after 5 years from diagnosis, the proportion of unknown cases for vital status was only 2%, which implies that the assessment of outcome was highly accurate. The other three prefectures did not have the resources to check the vital status of patients in the resident registry. Table 2 shows that the survival proportion from these three registries was higher than that from the other three referring resident registries. The best way to collect more accurate survival data are to assess patient outcome by referring to resident registries. However, the fact that these registries do not check the survival of patients appears to have a modest effect on the overestimation of survival, because death information is very precise in Japan, and collation could be done with high accuracy in these three prefectures. Further, the frequency of patients moving to different prefectures is considered to be relatively low.

Mucosal cancers of the large bowel should have been excluded from the survival analysis, since they are regarded as *in situ* cancers according to the agreement of the International Union Against Cancer (UICC) (29). However, some population-based cancer registries in Japan still do not distinguish them. In this study, it seems that the proportions of mucosal cancer of the large bowel and of multiple

primary cancers (except the first-diagnosed tumor) were negligible; it is therefore reasonable to think that they did not greatly affect survival results.

Future of Survival Analysis in Japan

The EUROCARE study is one of the most important collaborative studies of the European Union (9), currently involving 67 population-based cancer registries operating in 22 European countries (11). Furthermore, the CONCORD study extends the EUROCARE study to include North America (the USA and Canada), Australia and Asian countries, involving 101 population-based cancer registries in 31 countries (30). The International Agency for Research on Cancer has published an article on cancer survival in Africa, Asia and Central America recently including nine Asian countries (31), in addition, a similar international project on survival is ongoing in the Asia region; an Asian cancer registry network is being formed (32).

We confirmed the importance of calculating a comparable population-based survival as a measure of cancer control programs through the present study. Comparing the data chronologically and internationally, we figured out current situation, progress and international position of cancer screening and treatments in Japan. Drawing up a project or evaluating outcomes based on such a useful index is undoubtedly the basic principle of cancer control. Currently, it is highly recommended to analyze incidence, mortality and survival together in order to more fully understand the characteristics of cancer in a country (27,33). The Japanese research group is also conducting the MCIJ to monitor incidence, mortality and survival as the index of the progress of the cancer control routinely in Japan (34), and we hope to show the results to the world in the near future.

Conclusion

The study suggests an improvement in cancer survival in Japan in several primary sites during a relatively short period, which is consistent with the development of treatments and early detection. We confirmed that the overall survival of cancer patients in Japan is comparable with that in Europe. In contrast, the overall survival in the USA was much higher than Japan, but this is probably due to the difference of cancer incidence proportion.

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Conflict of interest statement

None declared.

References

1. Sakamoto K, Machi J, Prygrocki M, Watanabe T, Hosoda S, Sugano M, et al. Comparison of characteristics and survival of colorectal cancer between Japanese–Americans in Hawaii and native Japanese in Japan. *Dis Colon Rectum* 2006;49:50–7.
2. Ichinose Y, Kato H, Koike T, Tsuchiya R, Fujisawa T, Shimizu N, et al. Overall survival and local recurrence of 406 completely resected stage IIIa-N2 non-small cell lung cancer patients: questionnaire survey of the Japan Clinical Oncology Group to plan for clinical trials. *Lung Cancer* 2001;34:29–36.
3. Bunt AM, Hermans J, Smit VT, van de Velde CJ, Fleuren GJ, Bruijn JA. Surgical/pathologic-stage migration confounds comparisons of gastric cancer survival rates between Japan and Western countries. *J Clin Oncol* 1995;13:19–25.
4. Ajiki W, Matsuda T, Sato Y, Fujita M, Yamazaki S, Murakami R, et al. A standard method of calculating survival rates in population-based cancer registries. *Jpn J Cancer Clin* 1998;44:981–93.
5. Ajiki W, Matsuda T, Sato Y, Fujita M, Yamazaki S, Murakami R, et al. Standard method of calculating relative survival rates in population-based cancer registries—an investigation using stomach cancer patients. *Jpn J Cancer Clin* 1997;43:1005–14.
6. Oshima A, Ajiki W, Tsukuma H. Estimation of survival of cancer patients in Japan (preliminary report). In: Tajima K, Kuroishi T, Oshima A, editors. *Cancer Mortality and Morbidity Statistics: Japan and the World.* Tokyo: Japan Scientific Societies Press 2004;131–5.
7. Tsukuma H, Ajiki W, Ioka A, Oshima A, Research Group of Population-Based Cancer Registries of Japan. Survival of cancer patients diagnosed between 1993 and 1996: a collaborative study of population-based cancer registries in Japan. *Jpn J Clin Oncol* 2006;36:602–7.
8. Matsuda T, Marugame T, Kamo K, Katanoda K, Ajiki W, Sobue T. Cancer incidence and incidence rates in Japan in 2002: based on data from 11 population-based cancer registries. *Jpn J Clin Oncol* 2008;38:641–8.
9. Berrino F, Sant M, Verdecchia A, Capocaccia R, Hakulinen T, Esteve J. *Survival of Cancer Patients in Europe: The EUROCARE Study.* Lyon: International Agency for Research on Cancer 1995
10. Gloeckler Ries LA, Reichman ME, Lewis DR, Hankey BF, Edwards BK. Cancer survival and incidence from the Surveillance, Epidemiology, and End Results (SEER) program. *Oncologist* 2003;8:541–52.
11. Sant M, Allemani C, Santaquilani M, Knijn A, Marchesi F, Capocaccia R. EUROCARE-4. Survival of cancer patients diagnosed in 1995–1999. Results and commentary. *Eur J Cancer* 2009;45:931–91.
12. Ioka A, Ito Y, Tsukuma H. Factors relating to poor survival rates of aged cervical cancer patients: a population-based study with the relative survival model in Osaka, Japan. *Asian Pac J Cancer Prev* 2009;10:457–62.
13. Farley JH, Nycum LR, Birrer MJ, Park RC, Taylor RR. Age-specific survival of women with endometrioid adenocarcinoma of the uterus. *Gynecol Oncol* 2000;79:86–9.
14. Sorensen JT, Gerald K, Bodensteiner D, Holmes FF. Effect of age on survival in acute leukemia. 1950–1990. *Cancer* 1993;72:1602–6.