



Original Article

Health Inequities in Cancer Incidence According to Economic Status and Regions Are Still Existed Even under Universal Health Coverage System in Korea: A Nationwide Population Based Study Using the National Health Insurance Database

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Purpose The purpose of this study is to determine the level of health equity in relation to cancer incidence.

Materials and Methods We used the National Health Insurance (NHI) claims data of the National Health Insurance Service between 2005 and 2022 and annual health insurance and medical aid beneficiaries between 2011 and 2021 to investigate the disparities of cancer incidence. We calculated age-sex standardized cancer incidence rates by cancer and year according to the type of insurance and the trend over time using the annual percentage change. We also compared the hospital type of the first diagnosis by cancer type and year and cancer incidence rates by cancer type and region in 2021 according to the type of insurance.

Results The total cancer incidence increased from 255,971 in 2011 to 325,772 cases in 2021. The absolute difference of total cancer incidence rate between the NHI beneficiaries and the medical aid (MA) recipients increased from 510.1 cases per 100,000 population to 536.9 cases per 100,000 population. The odds ratio of total cancer incidence for the MA recipients increased from 1.79 (95% confidence interval [CI], 1.77 to 1.82) to 1.90 (95% CI, 1.88 to 1.93). Disparities in access to hospitals and regional cancer incidence were profound.

Conclusion This study examined health inequities in relation to cancer incidence over the last decade. Cancer incidence was higher in the MA recipients, and the gap was widening. We also found that regional differences in cancer incidence still exist and are getting worse. Investigating these disparities between the NHI beneficiaries and the MA recipients is crucial for implementing of public health policies to reduce health inequities.

Key words Health inequities, Cancer incidence, National Health Programs, Korea

Introduction

Despite of substantial advancements in the diagnosis and treatment technologies for cancer, cancer remains a prominent global burden, ranking among the most severe chronic illnesses worldwide. The global burden of disease study revealed that, in 2013, there were 14.9 million reported cancer incidence cases and 8.2 million cancer-related fatalities on a global scale [1]. In South Korea, in 2016, approximately 220,000 individuals were newly diagnosed with cancer, and around 78,000 died from cancer [2].

Several studies reported that there is socioeconomic inequity not only in the treatment of cancer but also in its incidence [3-10]. Several research conducted in Europe have indicated that individuals with low socioeconomic status tend to exhibit higher cancer incidence compared to indi-

viduals with high socioeconomic status [6-8].

South Korea is a nation with relatively low financial burdens regarding cancer diagnosis and treatment. The National Health Insurance (NHI) mandates that all citizens enroll in health insurance and provides financial assistance through the medical aid (MA) for those unable to afford medical insurance premiums. Consequently, South Korea achieved universal health coverage (UHC) [11]. Both the NHI and the MA in South Korea are encouraged to get regular cancer screening every 2 years. The out-of-pocket expenses for cancer screening are minimal, with the NHI covering up to 10% of the cost, and the MA offering screening at no cost to promote early cancer detection. Once a cancer diagnosis is confirmed, individuals with cancer are only required to bear 5% of their medical expenses.

The National Cancer Registry is very efficient and pro-

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Table 1. General characteristics of study subjects (thyroid cancer, lung cancer, colorectal cancer, stomach cancer, breast cancer, and prostate cancer): year 2011-2016

	2011			2012			2013			2014			2015			2016		
	No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD	
Total insurance																		
Total	50,908,646			51,169,141			51,448,491			51,757,146			52,034,424			52,272,755		
NHI beneficiaries	49,299,165	96.8		49,662,097	97.1		49,989,620	97.2		50,316,384	97.2		50,490,157	97.0		50,763,283	97.1	
MA recipients	1,609,481	3.2		1,507,044	2.9		1,458,871	2.8		1,440,762	2.8		1,544,267	3.0		1,509,472	2.9	
Total cancer (sum)																		
Total N	255,971			260,617			264,890			260,175			256,986			280,040		
No. of patients																		
Age (yr)																		
Age_Mean	59.9	15.0		60.2	14.9		60.6	14.9		61.3	14.9		62.0	14.9		62.3	14.9	
Age group (yr)																		
< 20	2,326	0.9		1,975	0.8		1,811	0.7		1,841	0.7		1,804	0.7		1,905	0.7	
20-29	4,146	1.6		4,076	1.6		4,071	1.5		3,933	1.5		3,465	1.3		4,110	1.5	
30-39	16,566	6.5		16,518	6.3		16,447	6.2		14,527	5.6		13,009	5.1		13,896	5.0	
40-49	37,725	14.7		37,336	14.3		38,108	14.4		34,903	13.4		32,661	12.7		34,412	12.3	
50-59	60,150	23.5		61,325	23.5		61,226	23.1		58,470	22.5		56,044	21.8		59,569	21.3	
60-69	58,483	22.8		58,318	22.4		58,480	22.1		58,790	22.6		60,658	23.6		67,651	24.2	
70-79	56,319	22.0		59,179	22.7		60,835	23.0		61,356	23.6		60,693	23.6		65,246	23.3	
≥ 80	20,256	7.9		21,890	8.4		23,912	9.0		26,355	10.1		28,652	11.1		33,251	11.9	
Sex																		
Male	129,084	50.4		130,245	50.0		132,956	50.2		133,727	51.4		134,494	52.3		145,340	51.9	
Female	126,887	49.6		130,372	50.0		131,934	49.8		126,448	48.6		122,492	47.7		134,700	48.1	
Insurance																		
NHI beneficiaries	242,583	94.8		248,441	95.3		252,499	95.3		247,269	95.0		244,031	95.0		265,411	94.8	
MA recipients	13,388	5.2		12,176	4.7		12,391	4.7		12,906	5.0		12,955	5.0		14,629	5.2	
Thyroid																		
Total N	41,700			45,915			44,456			33,512			26,066			27,704		
No. of patients																		
Age (yr)																		
Age_Mean	48.6	12.0		49.0	12.2		48.7	12.3		48.7	12.5		48.6	12.8		48.7	13.1	
Age group (yr)																		
< 20	168	0.4		165	0.4		172	0.4		180	0.5		156	0.6		148	0.5	
20-29	1,900	4.6		1,992	4.3		2,079	4.7		1,758	5.2		1,433	5.5		1,713	6.2	
30-39	7,711	18.5		8,273	18.0		8,201	18.4		6,031	18.0		4,840	18.6		5,236	18.9	
40-49	12,218	29.3		12,817	27.9		12,842	28.9		9,509	28.4		7,397	28.4		7,661	27.7	
50-59	12,302	29.5		13,875	30.2		12,986	29.2		9,719	29.0		7,179	27.5		7,302	26.4	

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Table 1. Continued

	2011		2012		2013		2014		2015		2016	
	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD
60-69	5,295	12.7	6,253	13.6	5,753	12.9	4,435	13.2	3,561	13.7	3,856	13.9
70-79	1,890	4.5	2,261	4.9	2,130	4.8	1,626	4.9	1,255	4.8	1,464	5.3
≥ 80	216	0.5	279	0.6	293	0.7	254	0.8	245	0.9	324	1.2
Sex												
Male	7,261	17.4	8,281	18.0	8,726	19.6	6,643	19.8	5,562	21.3	5,832	21.1
Female	34,439	82.6	37,634	82.0	35,730	80.4	26,869	80.2	20,504	78.7	21,872	78.9
Insurance												
NHI beneficiaries	40,787	97.8	45,091	98.2	43,646	98.2	32,856	98.0	25,553	98.0	27,104	97.8
MA recipients	913	2.2	824	1.8	810	1.8	656	2.0	513	2.0	600	2.2
Lung												
Total N												
No. of patients	22,166		22,618		23,719		24,631		24,887		27,093	
Age (yr)	67.9	11.4	68.3	11.2	68.5	11.3	68.9	11.3	69.0	11.3	69.1	11.3
Age group (yr)												
< 20	12	0.1	14	0.1	17	0.1	8	0	15	0.1	19	0.1
20-29	52	0.2	38	0.2	46	0.2	46	0.2	43	0.2	48	0.2
30-39	240	1.1	215	1.0	223	0.9	245	1.0	221	0.9	219	0.8
40-49	1,101	5.0	1,028	4.5	1,019	4.3	1,031	4.2	1,005	4.0	1,037	3.8
50-59	3,574	16.1	3,567	15.8	3,736	15.8	3,686	15.0	3,674	14.8	3,962	14.6
60-69	6,236	28.1	6,115	27.0	6,284	26.5	6,483	26.3	6,749	27.1	7,633	28.2
70-79	7,855	35.4	8,292	36.7	8,783	37.0	9,065	36.8	8,885	35.7	9,224	34.0
≥ 80	3,096	14.0	3,349	14.8	3,611	15.2	4,067	16.5	4,295	17.3	4,951	18.3
Sex												
Male	15,470	69.8	15,577	68.9	16,467	69.4	17,091	69.4	17,375	69.8	18,536	68.4
Female	6,696	30.2	7,041	31.1	7,252	30.6	7,540	30.6	7,512	30.2	8,557	31.6
Insurance												
NHI beneficiaries	20,635	93.1	21,122	93.4	22,195	93.6	23,031	93.5	23,242	93.4	25,296	93.4
MA recipients	1,531	6.9	1,496	6.6	1,524	6.4	1,600	6.5	1,645	6.6	1,797	6.6
Colon and rectum												
Total N												
No. of patients	28,905		29,550		29,198		28,801		28,517		30,498	
Age (yr)	64.2	12.4	64.4	12.5	64.8	12.6	65.2	12.7	65.7	12.7	66.0	12.8

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Table 1. Continued

	2011		2012		2013		2014		2015		2016	
	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD
Age group (yr)												
<20	16	0.1	15	0.1	9	0	9	0	10	0	18	0.1
20-29	109	0.4	108	0.4	82	0.3	119	0.4	101	0.4	119	0.4
30-39	708	2.4	753	2.5	750	2.6	654	2.3	632	2.2	654	2.1
40-49	2,598	9.0	2,613	8.8	2,526	8.7	2,380	8.3	2,199	7.7	2,272	7.4
50-59	6,682	23.1	6,729	22.8	6,605	22.6	6,426	22.3	6,098	21.4	6,383	20.9
60-69	8,148	28.2	7,941	26.9	7,614	26.1	7,479	26.0	7,542	26.4	8,226	27.0
70-79	7,801	27.0	8,232	27.9	8,123	27.8	8,021	27.8	7,937	27.8	8,127	26.6
≥ 80	2,843	9.8	3,159	10.7	3,489	11.9	3,713	12.9	3,998	14.0	4,699	15.4
Sex												
Male	17,528	60.6	17,761	60.1	17,588	60.2	17,166	59.6	16,924	59.3	18,102	59.4
Female	11,377	39.4	11,789	39.9	11,610	39.8	11,635	40.4	11,593	40.7	12,396	40.6
Insurance												
NHI beneficiaries	27,307	94.5	28,057	94.9	27,712	94.9	27,270	94.7	26,949	94.5	28,691	94.1
MA recipients	1,598	5.5	1,493	5.1	1,486	5.1	1,531	5.3	1,568	5.5	1,807	5.9
Stomach												
Total N	33,368		32,234		31,686		31,426		30,791		32,743	
Age (yr)	63.3	12.6	63.7	12.6	64.2	12.6	64.4	12.6	64.7	12.6	65.2	12.4
Age group (yr)												
<20	8	0	6	0	5	0	2	0	4	0	4	0
20-29	128	0.4	107	0.3	88	0.3	86	0.3	62	0.2	75	0.2
30-39	999	3.0	897	2.8	823	2.6	731	2.3	701	2.3	670	2.0
40-49	3,639	10.9	3,251	10.1	3,159	10.0	3,158	10.0	2,933	9.5	2,899	8.9
50-59	7,846	23.5	7,472	23.2	7,212	22.8	6,996	22.3	6,762	22.0	7,067	21.6
60-69	8,931	26.8	8,458	26.2	8,286	26.2	8,304	26.4	8,411	27.3	9,130	27.9
70-79	8,777	26.3	8,931	27.7	8,783	27.7	8,555	27.2	8,132	26.4	8,599	26.3
≥ 80	3,040	9.1	3,112	9.7	3,330	10.5	3,594	11.4	3,786	12.3	4,299	13.1
Sex												
Male	22,486	67.4	21,815	67.7	21,237	67.0	21,163	67.3	20,682	67.2	22,075	67.4
Female	10,882	32.6	10,419	32.3	10,449	33.0	10,263	32.7	10,109	32.8	10,668	32.6
Insurance												
NHI beneficiaries	31,674	94.9	30,713	95.3	30,189	95.3	29,844	95.0	29,321	95.2	31,156	95.2
MA recipients	1,694	5.1	1,521	4.7	1,497	4.7	1,582	5.0	1,470	4.8	1,587	4.8

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Table 1. Continued

	2011		2012		2013		2014		2015		2016	
	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD
Breast												
Total N	18,362		18,441		19,472		20,600		21,774		25,014	
No. of patients												
Age (yr)	51.8	11.3	52.3	11.4	52.3	11.4	52.7	11.5	53.0	11.5	53.5	11.7
Age group (yr)												
<20	7	0	5	0	4	0	4	0	4	0	3	0
20-29	175	1.0	176	1.0	167	0.9	163	0.8	163	0.7	187	0.7
30-39	1,975	10.8	1,782	9.7	1,834	9.4	1,899	9.2	1,808	8.3	2,085	8.3
40-49	6,259	34.1	6,252	33.9	6,680	34.3	6,894	33.5	7,197	33.1	8,071	32.3
50-59	5,851	31.9	5,783	31.4	6,183	31.8	6,591	32.0	6,897	31.7	7,758	31.0
60-69	2,611	14.2	2,751	14.9	2,799	14.4	3,040	14.8	3,575	16.4	4,227	16.9
70-79	1,211	6.6	1,393	7.6	1,459	7.5	1,584	7.7	1,668	7.7	2,050	8.2
≥80	273	1.5	299	1.6	346	1.8	425	2.1	462	2.1	633	2.5
Sex												
Male	130	0.7	109	0.6	96	0.5	112	0.5	116	0.5	115	0.5
Female	18,232	99.3	18,332	99.4	19,376	99.5	20,488	99.5	21,658	99.5	24,899	99.5
Insurance												
NHI beneficiaries	17,584	95.8	17,804	96.5	18,827	96.7	19,907	96.6	21,024	96.6	24,134	96.5
MA recipients	778	4.2	637	3.5	645	3.3	693	3.4	750	3.4	880	3.5
Prostate												
Total N	9,621		9,777		10,145		10,406		10,691		12,447	
No. of patients (yr)												
Age	70.5	8.4	70.8	8.5	70.6	8.4	70.9	8.4	71.1	8.5	71.2	8.5
Age group (yr)												
<20	3	0	3	0	-	0	2	0	2	0	-	0
20-29	1	0	1	0	2	0	1	0	3	0	2	0
30-39	10	0.1	5	0.1	3	0	1	0	4	0	2	0
40-49	77	0.8	69	0.7	80	0.8	72	0.7	59	0.6	91	0.7
50-59	867	9.0	897	9.2	947	9.3	953	9.2	945	8.8	1,049	8.4
60-69	3,200	33.3	3,029	31.0	3,147	31.0	3,202	30.8	3,405	31.8	3,980	32.0
70-79	4,234	44.0	4,403	45.0	4,632	45.7	4,674	44.9	4,615	43.2	5,344	42.9
≥80	1,229	12.8	1,370	14.0	1,334	13.1	1,501	14.4	1,658	15.5	1,979	15.9

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Table 1. Continued

	2011			2012			2013			2014			2015			2016		
	No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD	
Sex																		
Male	9,621	100		9,777	100		10,145	100		10,406	100		10,691	100		12,447	100	
Insurance																		
NHI beneficiaries	9,157	95.2		9,415	96.3		9,742	96.0		9,999	96.1		10,248	95.9		11,940	95.9	
MA recipients	464	4.8		362	3.7		403	4.0		407	3.9		443	4.1		507	4.1	

MA, medical aid; NHI, National Health Insurance; SD, standard deviation.

vides national cancer statistics. The National Cancer Registry provides highly accurate and detailed information on cancer incidence, mortality, and survival rates by cancer type, age group, sex, and region, including personal information such as patient’s social security number, address, and occupation, as well as various clinical information such as surveillance, epidemiology, and end results stage, metastasis, and differentiation, as well as date and cause of death and type of treatment.

However, this data does not include a variable to categorize the income level of patients, making it difficult to identify differences by economic level, which is one of the important factors in cancer incidence and mortality. The NHI claims data contains information on healthcare utilization related to the occurrence of cancer diseases and information on the type of health insurance coverage, which may indirectly reflect the income of cancer patients. Although more sophisticated results can be obtained by combining the National Cancer Registry data and the NHI claims data through additional work, we utilized the NHI claims data for efficient production of data and securing recent information. Because of the high correlation between the National Cancer Registry data and the NHI claims data on cancer incidence, the NHI claims data can be used to compare health disparities between the NHI beneficiaries and the MA recipients.

In previous studies utilizing the National Cancer Registry in South Korea, the nationwide cancer incidence is well-documented, but there is a lack of data regarding the socioeconomic status. Therefore, we aim to investigate the impact of socioeconomic status on cancer incidence using the NHI claims data. This study aims to investigate under the UHC whether: (1) there exists inequality in cancer incidence based on socioeconomic status, particularly insurance types and geographic regions; (2) whether such inequality is increasing; and (3) whether inequality exists in cancer treatment facilities based on socioeconomic status.

Materials and Methods

1. Data sources

To define patients with newly diagnosed cancer between 2011 and 2021, we used the NHI claims data of the National Health Insurance Service from 2005 through 2022, with a washout period of 5 years and a subsequent 1-year follow-up period to define episodes for patients in 2021. The NHI claims data contains information about patients (age, sex, type of insurance, diagnosis and treatment history, etc.) This is representative of data from almost all citizens, including the NHI and the MA patients [12,13].

Furthermore, we used the National Health Insurance Ser-

Table 2. General characteristics of study subjects (thyroid cancer, lung cancer, colorectal cancer, stomach cancer, breast cancer, and prostate cancer): year 2017-2021

	2017			2018			2019			2020			2021		
	No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD	
Total insurance															
Total	52,426,625			52,556,653			52,880,293			52,870,968			52,928,662		
NHI beneficiaries	50,940,885	97.2		51,071,982	97.2		51,391,447	97.2		51,344,938	97.1		51,412,137	97.1	
MA recipients	1,485,740	2.8		1,484,671	2.8		1,488,846	2.8		1,526,030	2.9		1,516,525	2.9	
Total cancer (sum)															
Total N	282,134			287,489			300,433			293,644			325,772		
No. of patients															
Age (yr)															
Age_Mean	62.7	14.9		62.8	14.9		63.1	14.9		63.3	15.0		63.1	15.1	
Age group (yr)															
< 20	1,629	0.6		1,529	0.5		1,503	0.5		1,522	0.5		1,570	0.5	
20-29	3,912	1.4		4,182	1.5		4,449	1.5		4,553	1.6		5,337	1.6	
30-39	13,840	4.9		14,479	5.0		14,615	4.9		14,116	4.8		16,257	5.0	
40-49	34,109	12.1		33,883	11.8		34,309	11.4		32,852	11.2		37,481	11.5	
50-59	57,889	20.5		57,917	20.1		59,192	19.7		55,682	19.0		60,268	18.5	
60-69	68,500	24.3		70,198	24.4		75,109	25.0		74,988	25.5		85,384	26.2	
70-79	66,736	23.7		67,711	23.6		70,431	23.4		68,482	23.3		73,180	22.5	
≥ 80	35,519	12.6		37,590	13.1		40,825	13.6		41,449	14.1		46,295	14.2	
Sex															
Male	147,244	52.2		150,562	52.4		156,603	52.1		153,692	52.3		167,759	51.5	
Female	134,890	47.8		136,927	47.6		143,830	47.9		139,952	47.7		158,013	48.5	
Insurance															
NHI beneficiaries	267,448	94.8		272,481	94.8		284,681	94.8		278,149	94.7		308,526	94.7	
MA recipients	14,686	5.2		15,008	5.2		15,752	5.2		15,495	5.3		17,246	5.3	
Thyroid															
Total N	27,567			30,004			32,758			31,362			37,166		
No. of patients															
Age (yr)															
Age_Mean	48.6	13.2		48.5	13.3		48.8	13.3		48.4	13.4		48.6	13.5	
Age group (yr)															
< 20	164	0.6		147	0.5		159	0.5		166	0.5		171	0.5	
20-29	1,710	6.2		1,976	6.6		2,152	6.6		2,264	7.2		2,602	7.0	
30-39	5,387	19.5		6,011	20.0		6,277	19.2		6,131	19.5		7,228	19.4	
40-49	7,518	27.3		8,109	27.0		8,730	26.6		8,324	26.5		9,839	26.5	
50-59	7,124	25.8		7,598	25.3		8,427	25.7		7,703	24.6		8,893	23.9	

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Table 2. Continued

	2017		2018		2019		2020		2021	
	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD	No. or Mean	% or SD
60-69	3,923	14.2	4,214	14.0	4,767	14.6	4,783	15.3	6,013	16.2
70-79	1,409	5.1	1,596	5.3	1,840	5.6	1,602	5.1	1,922	5.2
≥ 80	332	1.2	353	1.2	406	1.2	389	1.2	498	1.3
Sex										
Male	6,216	22.5	6,966	23.2	7,909	24.1	7,748	24.7	9,111	24.5
Female	21,351	77.5	23,038	76.8	24,849	75.9	23,614	75.3	28,055	75.5
Insurance										
NHI beneficiaries	27,033	98.1	29,387	97.9	32,108	98.0	30,780	98.1	36,438	98.0
MA recipients	534	1.9	617	2.1	650	2.0	582	1.9	728	2.0
Lung										
Total N										
No. of patients	28,010		29,323		30,302		29,494		31,637	
Age (yr)										
Age_Mean	69.5	11.1	69.7	11.1	69.9	11.0	70.1	11.0	70.2	11.0
Age group (yr)										
< 20	6	0	5	0	7	0	7	0	3	0
20-29	44	0.2	41	0.1	45	0.1	38	0.1	45	0.1
30-39	185	0.7	221	0.8	232	0.8	212	0.7	235	0.7
40-49	1,048	3.7	1,027	3.5	998	3.3	931	3.2	992	3.1
50-59	3,917	14.0	3,903	13.3	3,825	12.6	3,538	12.0	3,733	11.8
60-69	7,818	27.9	8,256	28.2	8,561	28.3	8,598	29.2	9,421	29.8
70-79	9,718	34.7	10,149	34.6	10,470	34.6	10,077	34.2	10,581	33.4
≥ 80	5,274	18.8	5,721	19.5	6,164	20.3	6,093	20.7	6,627	20.9
Sex										
Male	19,153	68.4	19,905	67.9	20,397	67.3	19,998	67.8	21,079	66.6
Female	8,857	31.6	9,418	32.1	9,905	32.7	9,496	32.2	10,558	33.4
Insurance										
NHI beneficiaries	26,072	93.1	27,322	93.2	28,242	93.2	27,383	92.8	29,397	92.9
MA recipients	1,938	6.9	2,001	6.8	2,060	6.8	2,111	7.2	2,240	7.1
Colon and rectum										
Total N										
No. of patients	30,361		29,798		30,728		29,196		35,258	
Age (yr)										
Age_Mean	66.0	13.0	66.4	13.0	66.4	13.1	66.2	13.4	64.9	14.2

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Table 2. Continued

	2017			2018			2019			2020			2021		
	No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD	
Age group (yr)															
<20	13	0	7	0	0	10	0	0	12	0	0	9	0	0	0
20-29	122	0.4	108	0.4	131	0.4	136	0.5	136	0.5	275	0.8	275	0.8	0.8
30-39	658	2.2	682	2.3	675	2.2	736	2.5	736	2.5	1,358	3.9	1,358	3.9	3.9
40-49	2,348	7.7	2,199	7.4	2,217	7.2	2,242	7.7	2,242	7.7	3,450	9.8	3,450	9.8	9.8
50-59	6,301	20.8	6,017	20.2	6,105	19.9	5,755	19.7	5,755	19.7	6,832	19.4	6,832	19.4	19.4
60-69	7,986	26.3	7,840	26.3	8,315	27.1	7,894	27.0	7,894	27.0	9,486	26.9	9,486	26.9	26.9
70-79	8,023	26.4	7,824	26.3	7,800	25.4	7,168	24.6	7,168	24.6	7,907	22.4	7,907	22.4	22.4
≥ 80	4,910	16.2	5,121	17.2	5,475	17.8	5,253	18.0	5,253	18.0	5,941	16.9	5,941	16.9	16.9
Sex															
Male	17,980	59.2	17,743	59.5	18,135	59.0	17,277	59.2	17,277	59.2	20,678	58.6	20,678	58.6	58.6
Female	12,381	40.8	12,055	40.5	12,593	41.0	11,919	40.8	11,919	40.8	14,580	41.4	14,580	41.4	41.4
Insurance															
NHI beneficiaries	28,557	94.1	28,024	94.0	28,747	93.6	27,310	93.5	27,310	93.5	33,097	93.9	33,097	93.9	93.9
MA recipients	1,804	5.9	1,774	6.0	1,981	6.4	1,886	6.5	1,886	6.5	2,161	6.1	2,161	6.1	6.1
Stomach															
Total N	31,976		30,888		31,103		28,282		28,282		31,517		31,517		
No. of patients															
Age (yr)															
Age_Mean	65.3	12.4	65.6	12.3	66.0	12.3	66.6	12.3	66.6	12.3	66.8	12.1	66.8	12.1	12.1
Age group (yr)															
<20	5	0	3	0	1	0	2	0	2	0	-	0	-	0	0
20-29	59	0.2	60	0.2	70	0.2	54	0.2	54	0.2	62	0.2	62	0.2	0.2
30-39	611	1.9	563	1.8	513	1.6	430	1.5	430	1.5	387	1.2	387	1.2	1.2
40-49	2,748	8.6	2,519	8.2	2,335	7.5	1,982	7.0	1,982	7.0	2,134	6.8	2,134	6.8	6.8
50-59	6,777	21.2	6,498	21.0	6,194	19.9	5,266	18.6	5,266	18.6	5,650	17.9	5,650	17.9	17.9
60-69	9,054	28.3	8,824	28.6	9,084	29.2	8,436	29.8	8,436	29.8	9,951	31.6	9,951	31.6	31.6
70-79	8,459	26.5	8,131	26.3	8,270	26.6	7,585	26.8	7,585	26.8	8,267	26.2	8,267	26.2	26.2
≥ 80	4,263	13.3	4,290	13.9	4,636	14.9	4,527	16.0	4,527	16.0	5,066	16.1	5,066	16.1	16.1
Sex															
Male	21,531	67.3	20,983	67.9	20,989	67.5	18,983	67.1	18,983	67.1	20,970	66.5	20,970	66.5	66.5
Female	10,445	32.7	9,905	32.1	10,114	32.5	9,299	32.9	9,299	32.9	10,547	33.5	10,547	33.5	33.5
Insurance															
NHI beneficiaries	30,421	95.1	29,382	95.1	29,518	94.9	26,793	94.7	26,793	94.7	29,903	94.9	29,903	94.9	94.9
MA recipients	1,555	4.9	1,506	4.9	1,585	5.1	1,489	5.3	1,489	5.3	1,614	5.1	1,614	5.1	5.1

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Table 2. Continued

	2017			2018			2019			2020			2021		
	No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD	
Breast															
Total N	25,981			26,874			28,361			28,327			32,541		
No. of patients															
Age (yr)															
Age_Mean	54.0	11.7		54.2	11.7		54.5	11.7		54.8	11.8		55.2	12.0	
Age group (yr)															
<20	6	0	1	0	0	5	0	0	6	0	0	2	0	0	
20-29	204	0.8	151	0.6	0.7	189	0.7	189	0.7	189	0.7	236	0.7	0.7	
30-39	2,046	7.9	2,055	7.6	7.5	2,135	7.5	2,010	7.1	2,010	7.1	2,116	6.5	6.5	
40-49	8,059	31.0	8,361	31.1	29.6	8,385	29.6	8,144	28.7	8,144	28.7	9,113	28.0	28.0	
50-59	7,964	30.7	8,249	30.7	30.4	8,614	30.4	8,621	30.4	8,621	30.4	9,793	30.1	30.1	
60-69	4,835	18.6	5,010	18.6	20.2	5,730	20.2	5,959	21.0	5,959	21.0	7,103	21.8	21.8	
70-79	2,183	8.4	2,282	8.5	8.8	2,503	8.8	2,527	8.9	2,527	8.9	3,047	9.4	9.4	
≥ 80	684	2.6	765	2.8	2.8	800	2.8	871	3.1	871	3.1	1,131	3.5	3.5	
Sex															
Male	160	0.6	144	0.5	0.5	142	0.5	158	0.6	158	0.6	160	0.5	0.5	
Female	25,821	99.4	26,730	99.5	99.5	28,219	99.5	28,169	99.4	28,169	99.4	32,381	99.5	99.5	
Insurance															
NHI beneficiaries	25,079	96.5	25,990	96.7	96.8	27,450	96.8	27,396	96.7	27,396	96.7	31,445	96.6	96.6	
MA recipients	902	3.5	884	3.3	3.2	911	3.2	931	3.3	931	3.3	1,096	3.4	3.4	
Prostate															
Total N	13,706		15,587			17,461		17,889		17,889		19,581			
No. of patients															
Age (yr)															
Age_Mean	71.5	8.5	71.5	8.5	8.4	71.6	8.4	72.1	8.4	72.1	8.4	72.1	8.5	8.5	
Age group (yr)															
<20	2	0	1	0	0	-	0	1	0	1	0	1	0	0	
20-29	1	0	1	0	0	1	0	-	0	-	0	2	0	0	
30-39	8	0.1	7	0	0.1	9	0.1	4	0	4	0	8	0	0	
40-49	70	0.5	94	0.6	0.5	85	0.5	78	0.4	78	0.4	91	0.5	0.5	
50-59	1,111	8.1	1,199	7.7	7.1	1,236	7.1	1,190	6.7	1,190	6.7	1,198	6.1	6.1	
60-69	4,201	30.7	4,772	30.6	31.3	5,470	31.3	5,368	30.0	5,368	30.0	6,056	30.9	30.9	
70-79	5,969	43.6	6,797	43.6	43.3	7,552	43.3	7,713	43.1	7,713	43.1	8,270	42.2	42.2	
≥ 80	2,344	17.1	2,716	17.4	17.8	3,108	17.8	3,535	19.8	3,535	19.8	3,955	20.2	20.2	

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Table 2. Continued

	2017			2018			2019			2020			2021		
	No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD		No. or Mean	% or SD	
Sex															
Male	13,706	100		15,587	100		17,461	100		17,889	100		19,581	100	
Insurance															
NHI beneficiaries	13,131	95.8		14,955	95.9		16,749	95.9		17,102	95.6		18,652	95.3	
MA recipients	575	4.2		632	4.1		712	4.1		787	4.4		929	4.7	

MA, medical aid; NHI, National Health Insurance; SD, standard deviation.

vice’s annual health insurance and medical aid beneficiaries from 2011 to 2021. These statistics include the number of beneficiaries for the NHI and the MA by province, age, and sex at the end of each year [14].

2. Definitions

All inpatient and outpatient claim with a primary diagnosis of C00-C96 according to the Korean Standard Classification of Diseases and Causes of Death-8 (KCD-8) and a special benefit code for registered cancer patients (V193) were extracted and considered as medical utilization due to cancer. All cancers were categorized as the 10 most diagnosed cancers in Korea based on the National Cancer Registry Statistics 2019, and the rest were categorized as other cancers. The 10 cancers included thyroid cancer (C73), lung cancer (C33-C34), colorectal cancer (C18-C20), stomach cancer (C16), breast cancer (C50), prostate cancer (C61), liver cancer (C22), pancreatic cancer (C25), gallbladder and biliary tract cancer (C23-C24), and kidney cancer (C64) [15].

We constructed episodes of patients’ healthcare use with data classified by cancer type to define a newly diagnosed cancer case. The first episode by year established between 2011 and 2021 was defined as a newly diagnosed cancer case (new claim for major diagnosis of C code and V193; special certification for cancer) in the year if there was no healthcare use due to the same cancer in the previous 5 years.

The hospital type of the first diagnosis was defined as the type of hospital used by the patient in the first episode of healthcare use due to specific cancer. It was classified into tertiary hospitals, general hospitals, hospitals, and clinics.

Geographic regions were defined based on the residence of patients diagnosed with new cancer and categorized into 17 provinces according to the administrative divisions of the Korean Ministry of the Interior and Safety.

3. Statistical analysis

General characteristics and the hospital type of the first diagnosis are presented as mean and standard deviation or number and percentage. The age-sex standardized cancer incidence rates by cancer type and year according to the type of insurance and the age-sex standardized cancer incidence rate by cancer type and province in 2021 according to the type of insurance were presented as the number of diagnosed cancer cases per 100,000 population of beneficiaries. Age standardization was performed using 10-year age groups, except that age standardization by region was done for those under age 60 and over age 60 due to few occurrences per cell. To determine the trend in cancer incidence over time by a different type of insurance, a log-linear Poisson regression model was used to compare the annual percentage change (APC). The odds ratio (OR) with 95% confidence intervals was also

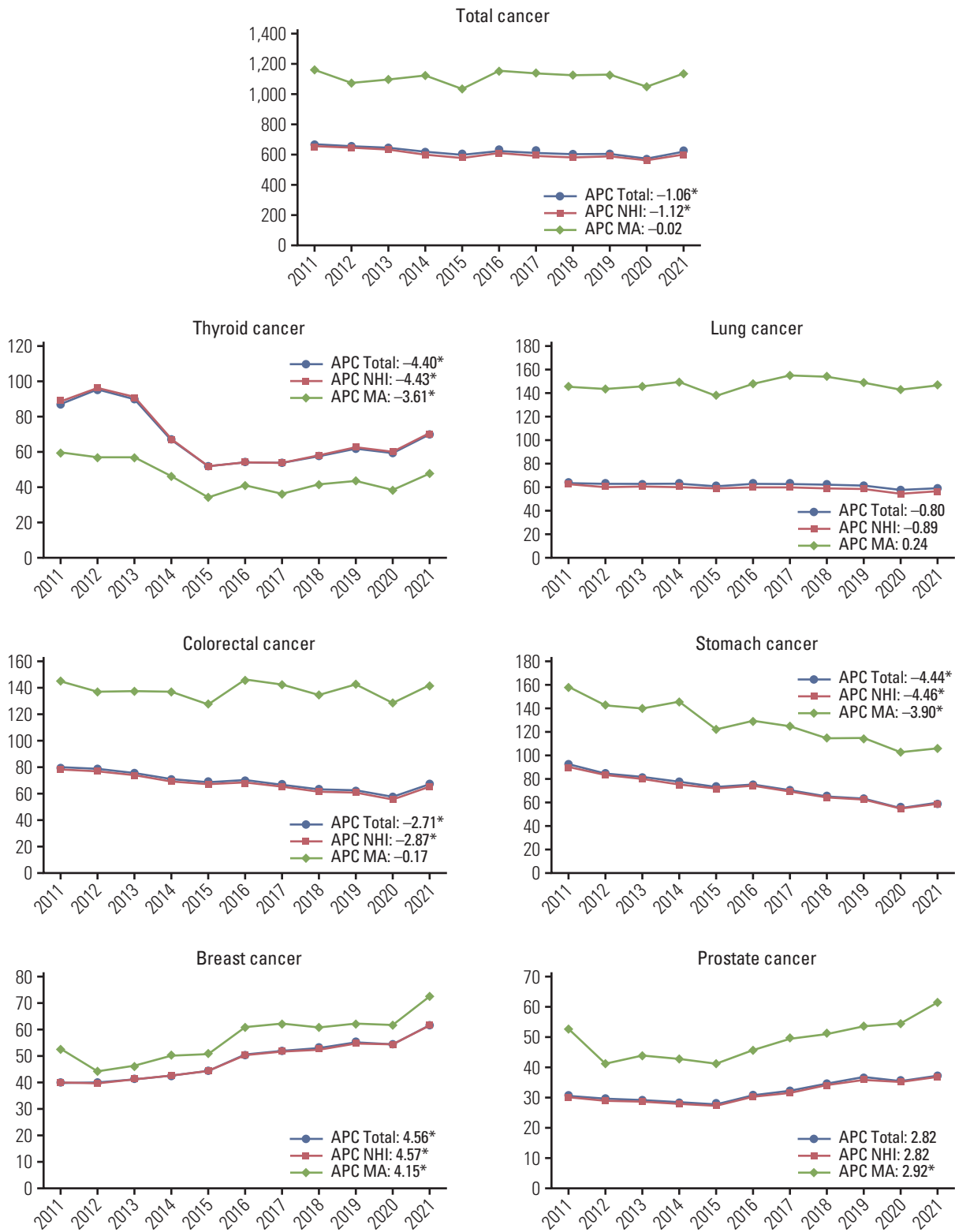


Fig. 1. Yearly age-sex standardized cancer incidence rates by cancer type (Units: cases per 100,000 population). APC, annual percentage change; MA, medical aid; NHI, National Health Insurance. * $p < 0.05$. (Continued to the next page)

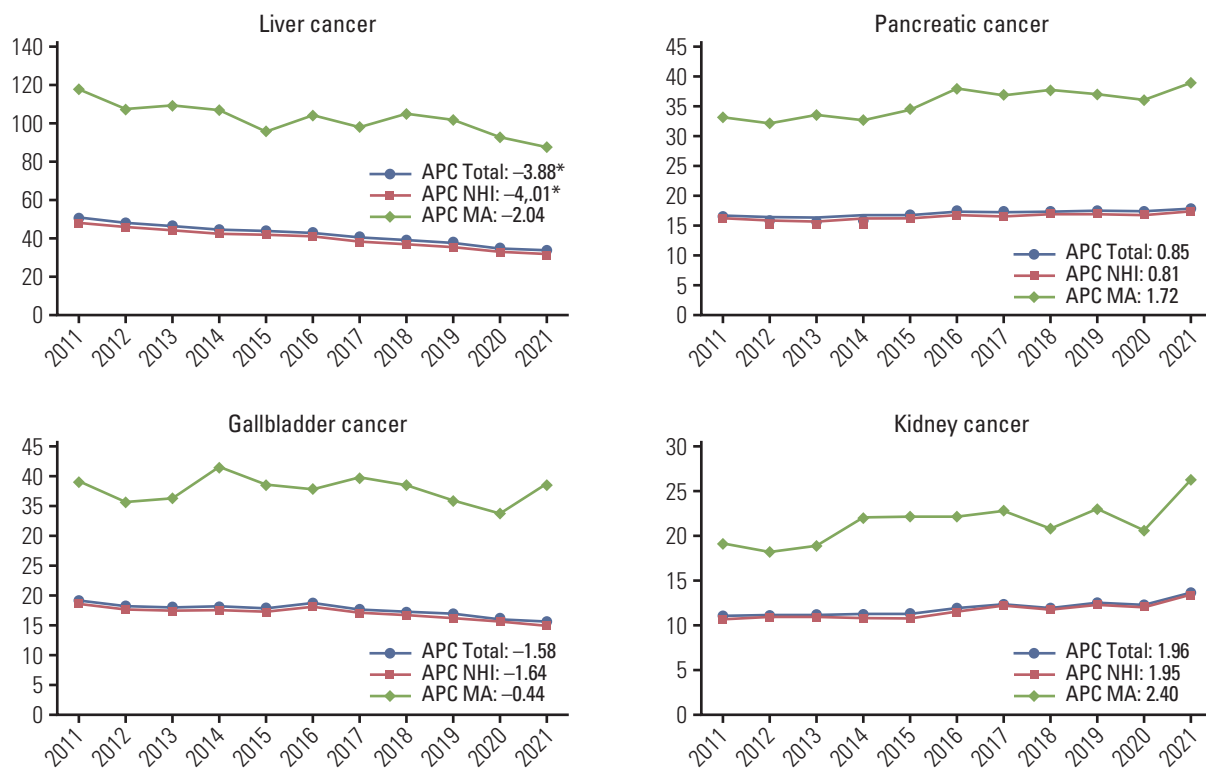


Fig. 1. (Continued from the previous page)

calculated using the NHI group as a reference to compare the risk of new cancer incidence between two health insurance types. The statistical significance level was set to 0.05. All statistical analyses in this study were calculated using SAS software ver. 9.4 (SAS Institute Inc., Cary, NC).

Results

1. General characteristics of cancer patients in Korea

The trend of total cancer incidence increased from 255,971 cases in 2011 to 325,772 cases in 2021. The cancers that have increased the most are, in order, breast cancer, prostate cancer, lung cancer, colorectal cancer, pancreatic cancer, kidney cancer, and gallbladder cancer. Cancers whose incidence has plateaued or declined are thyroid cancer, stomach cancer, and liver cancer. Breast cancer cases were 18,362 and 32,541 in 2011 and 2021, lung cancer cases were 22,166 and 31,637 in 2011 and 2021, and colorectal cancer cases were 28,905 and 35,258 in 2011 and 2021. Among total cancer cases, thyroid cancer had the highest incidence and decreasing trend, with 41,700 cases in 2011 to 37,166 cases in 2021. Stomach cancer cases were 33,368 and 31,517 in 2011 and 2021, and liver cancer cases were 18,455 and 17,668 in 2011 and 2021.

By age group, the number and proportion of total cancer cases were prominent in 50-59 years, 60-69 years, and 70-79 years age group, while the proportion of total cancer cases was less than 2% in the ≤ 29 years age group. In addition, the proportion of sex was similar between male and female, about 95% of total cancer cases were covered by the NHI, and about 5% were the MA recipients. The general characteristics of the study subjects are shown in Tables 1, 2 and S1 Table.

2. Age-sex standardized total cancer incidence by insurance type

As shown in Fig. 1 and S2 Table, The total cancer incidence rate showed an increasing trend, as did the NHI and the MA group. The gap between the NHI group and the MA group has widened from 2011 to 2021. The gap was lowest in 2012, with 434.1 cases per 100,000 population, and highest in 2016 at 550.1 cases per 100,000 population. By insurance type, the MA group had the higher cancer incidence rate than the NHI group. The total incidence rate of the NHI decreased from 652.0 cases per 100,000 population in 2011 to 600.4 cases per 100,000 population, whereas the total incidence rate of the MA decreased from 1,162.1 cases per 100,000 population in 2011 to 1,137.3 cases per 100,000 population. The absolute difference of total cancer incidence rate was 510.1 cases

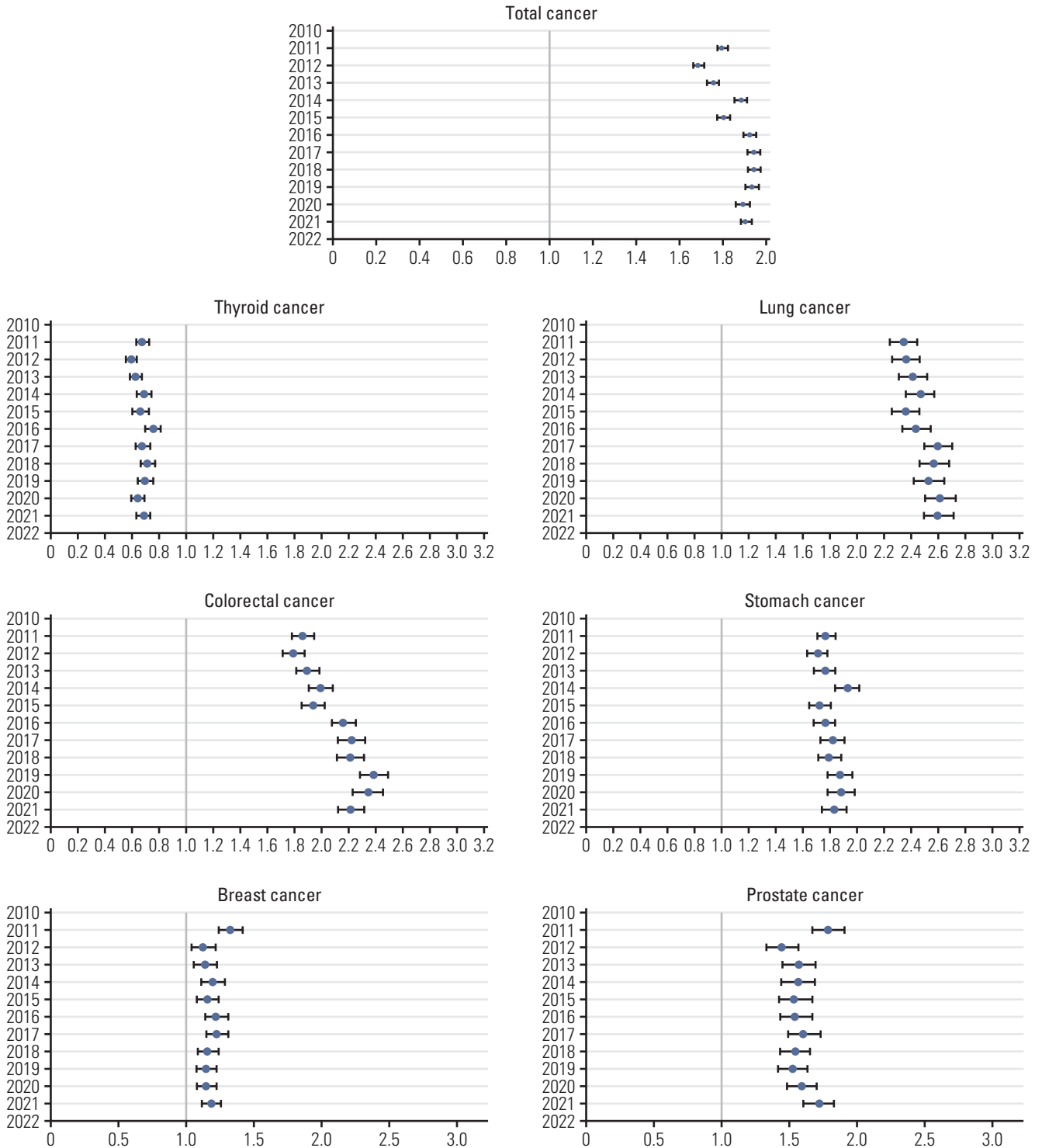


Fig. 2. Yearly odds ratio of cancer incidence by cancer type with 95% confidence interval (ref: the National Health Insurance). (Continued to the next page)

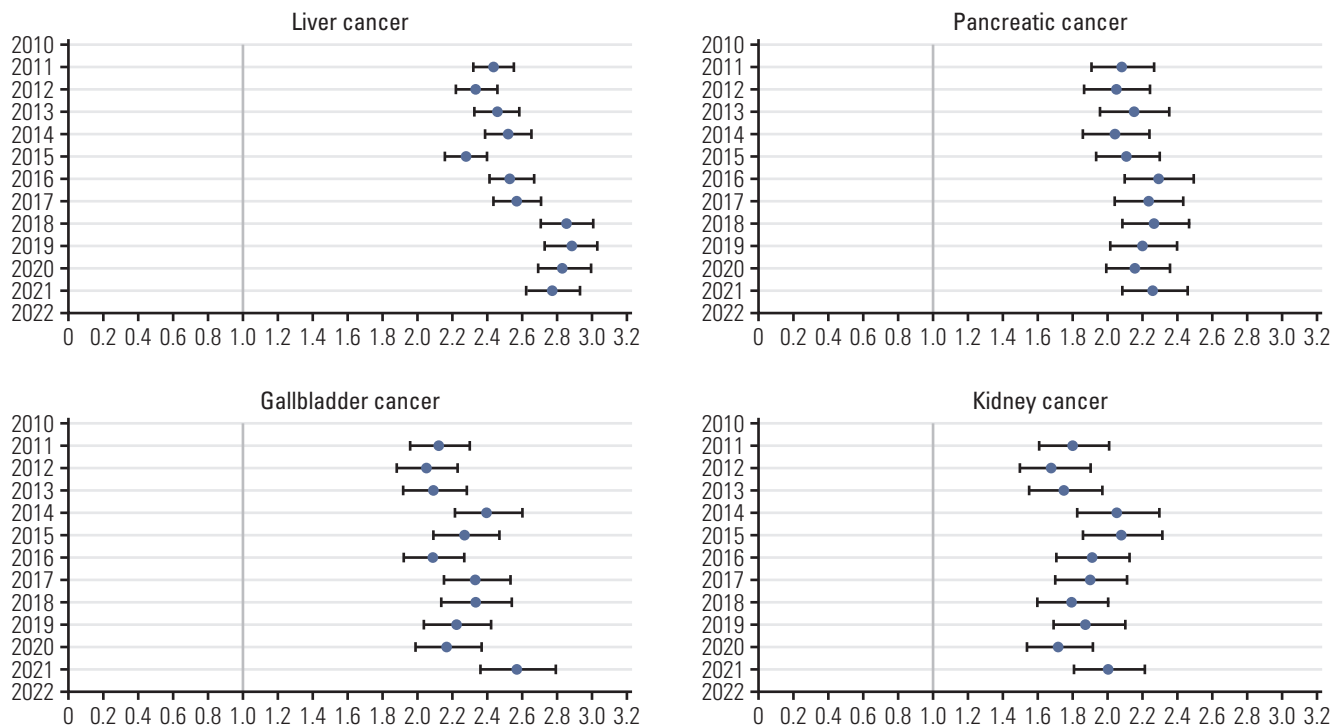


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per 100,000 population in 2011 and 536.9 cases per 100,000 population in 2021. The APC in total cancer in total population was -1.06% -point, with -1.12% -point, and -0.02% -point in the NHI and the MA groups. The incidence of all types of cancer was higher in the MA group, except thyroid cancer. The incidence of liver cancer and stomach cancer was in a decreasing pattern in the NHI group, -3.88% -point and -4.44% -point, respectively.

3. The OR of cancer incidence by insurance type

As Fig. 2 and S3 Table show the OR of cancer incidence by insurance type, the risk of total cancer incidence raised from 2011 to 2021. The OR of total cancer incidence showed an increasing pattern, with 1.79 (95% confidence interval [CI], 1.77 to 1.82), and 1.90 (95% CI, 1.88 to 1.93) in 2011 and 2021, respectively. The risk of all types of cancer incidence except thyroid cancer was significantly higher in the MA group than in the NHI group which is the reference. Cancers that have shown an increasing trend of the OR were lung cancer, colorectal cancer, stomach cancer, liver cancer, pancreatic cancer, gallbladder cancer, and kidney cancer. The OR of liver cancer was the highest among 10 types of cancer, 2.43 (95% CI, 2.31 to 2.54) in 2011 and 2.76 (95% CI, 2.61 to 2.92) in 2021. A decreasing trend of the OR was shown in breast cancer and prostate cancer. The OR of breast cancer was 1.32 (95% CI,

1.23 to 1.41), 1.18 (95% CI, 1.11 to 1.25) in 2011 and 2021. Only the OR of thyroid cancer incidence was less than 1. The OR was 0.67 (95% CI, 0.63 to 0.72) and 0.68 (95% CI, 0.63 to 0.73) in 2011 and 2021, respectively.

4. Disparities in hospital type of first diagnosis in cancer

In the MA group, the proportion of general hospitals was higher than the proportion of tertiary hospitals, with 61.4% of general hospitals and 28.5% of tertiary hospitals in 2011. However, the gap between general hospitals and tertiary hospitals has narrowed, with 38.7% of general hospitals and 54.0% of tertiary hospitals in 2021. Fig. 3 and S4-S6 Tables show the proportion of the type of hospital where patients were first diagnosed with cancer. The proportion was highest in tertiary hospitals, followed by general hospitals, hospitals, and local clinics in the NHI group. The sum of proportion of hospitals and local clinics was less than 10% in both groups. Since 2017, the proportion of tertiary hospitals for the first cancer diagnosis in the MA group has increased, however, it is still approximately 10% different from the NHI group.

5. Regional disparities in cancer incidence by insurance type

All regions showed differences in cancer incidence by insurance type. The cancer incidence rate was higher in the

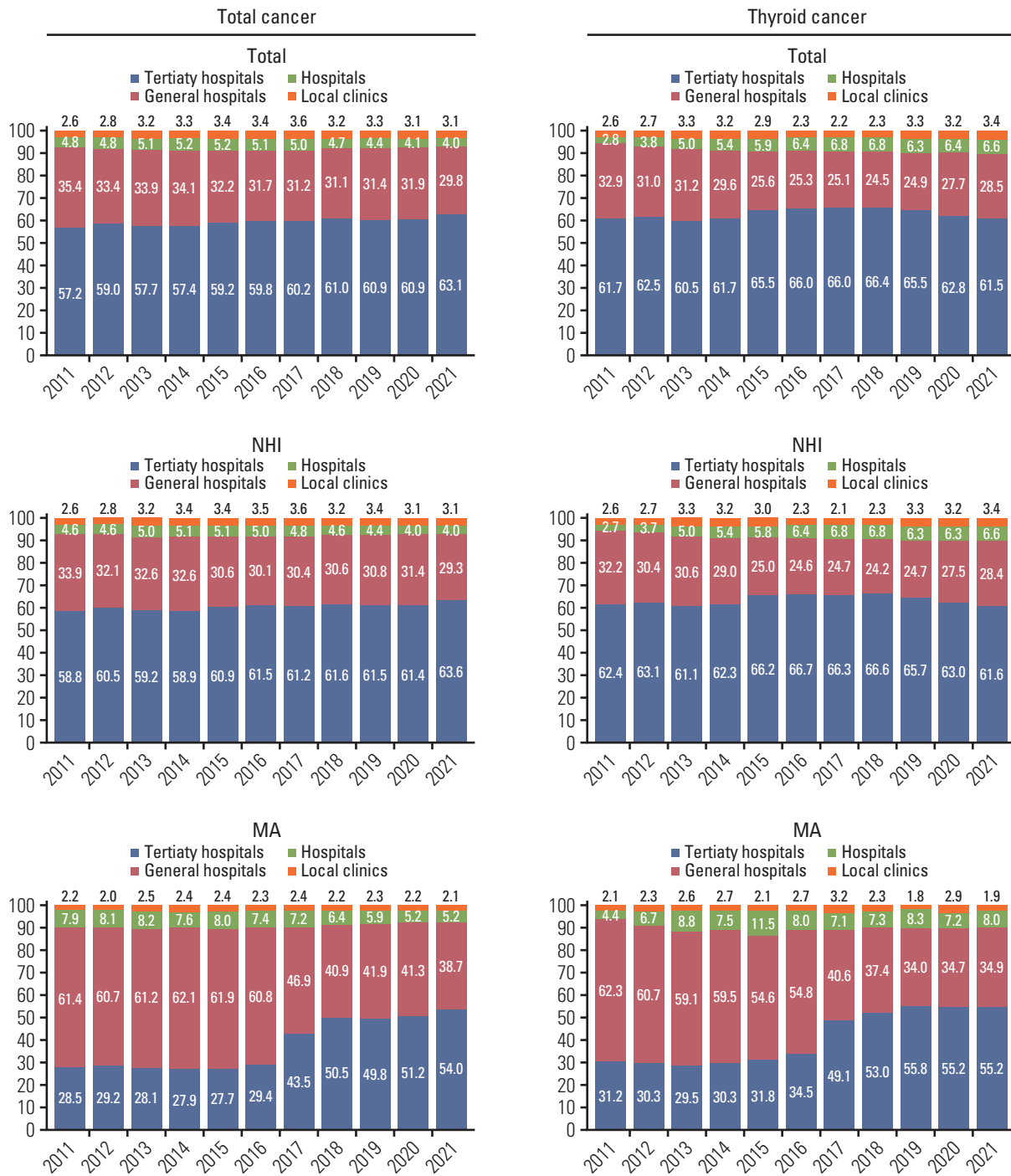


Fig. 3. Hospital types at the first diagnosis of cancer by year (Units: %). MA, medical aid; NHI, National Health Insurance. (Continued to the next page)

MA group than in the NHI group in every province. Fig. 4 and S7 Table show the regional disparities in cancer incidence by insurance type in 2021. Nationwide total cancer incidence rates were 605.4 cases per 100,000 population.

Nationwide cancer incidence rates in the NHI and the MA groups were 589.9 cases per 100,000 population and 1,133.1 cases per 100,000 population. Disparities between insurance types also vary by region, with most provinces showing gap

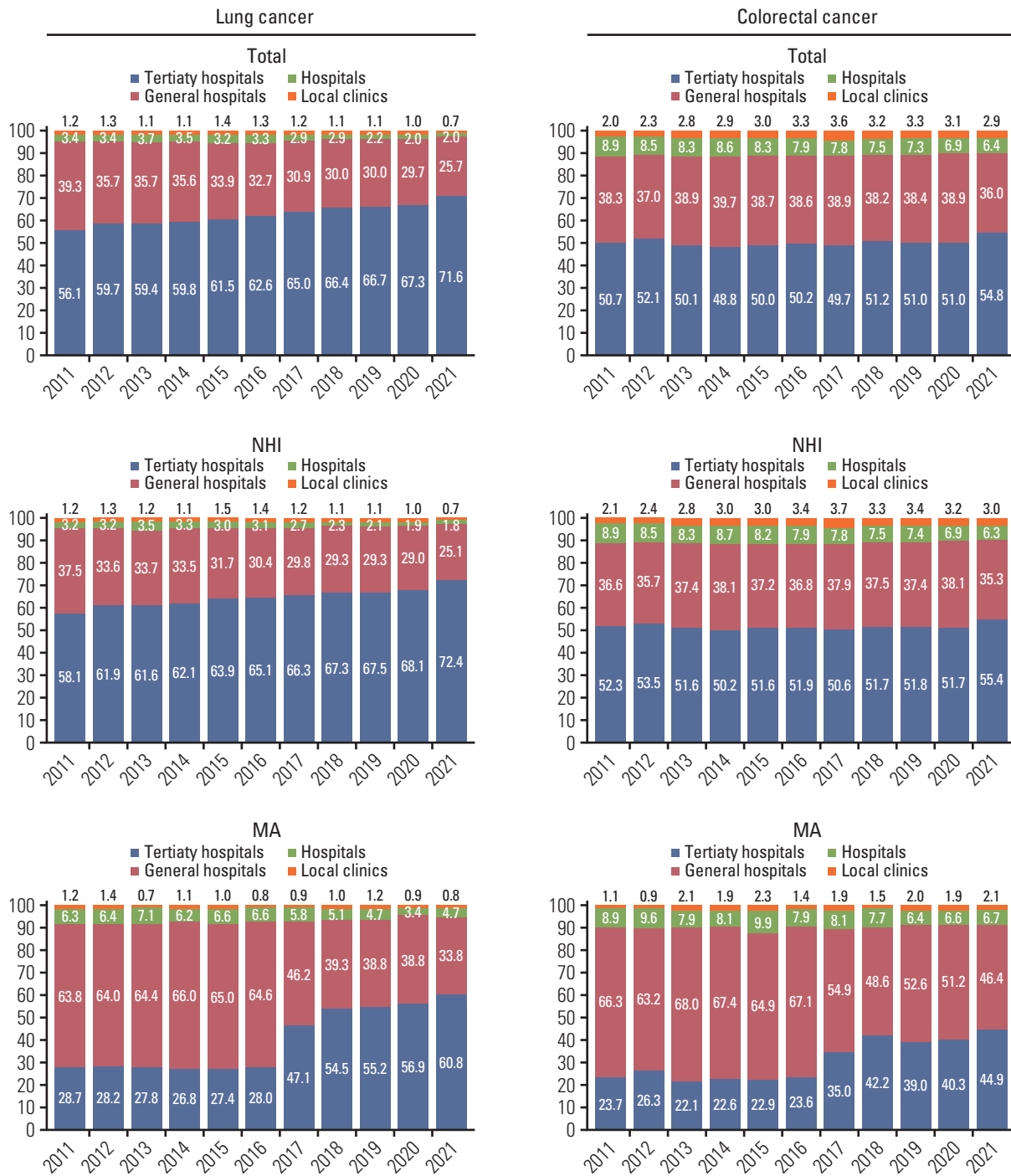


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of approximately two-to-one between the NHI and the MA groups, while some provinces showed a smaller gap. Busan had the highest overall cancer rate at 646.1 cases per 100,000 population, while Jeju had the lowest overall cancer rate at 570.4 cases per 100,000 population.

Discussion

This study is the first paper to examine health inequities in relation to cancer incidence between the NHI beneficiaries and the MA recipients over the last decade in Korea. Cancer

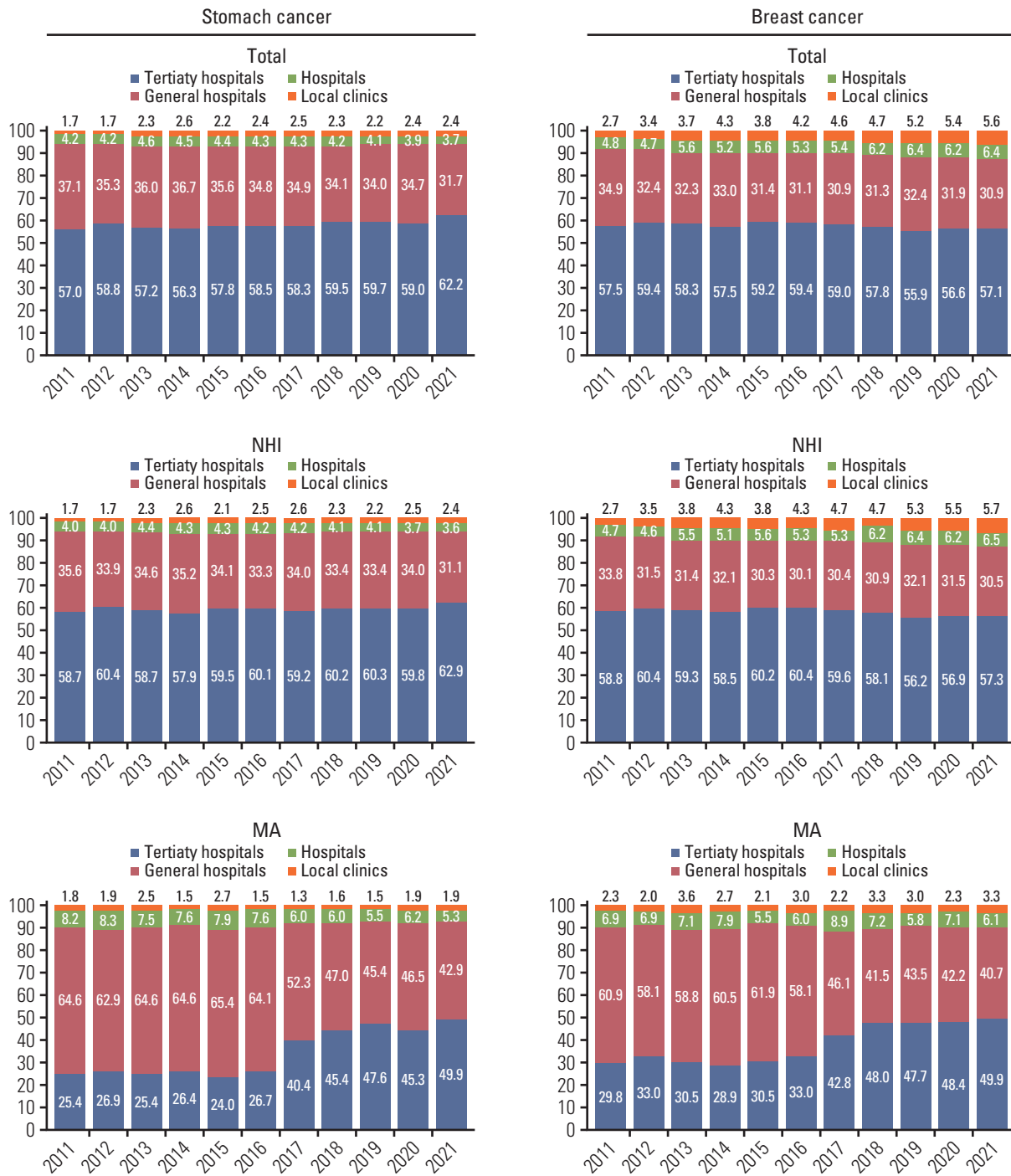


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incidence has increased overall, and this trend was found in both the NHI group and the MA group. However, we found that cancer incidence was higher in the MA group than in the NHI group, and that the gap was widening. We also found that regional differences in cancer incidence still exist and are

getting worse.

In addition, the risk of cancer incidence showed the same pattern as cancer incidence rates. The OR was higher in the MA group than in the NHI group. The OR of total cancer incidence was 1.79 (95% CI, 1.77 to 1.82) and 1.90 (95% CI,

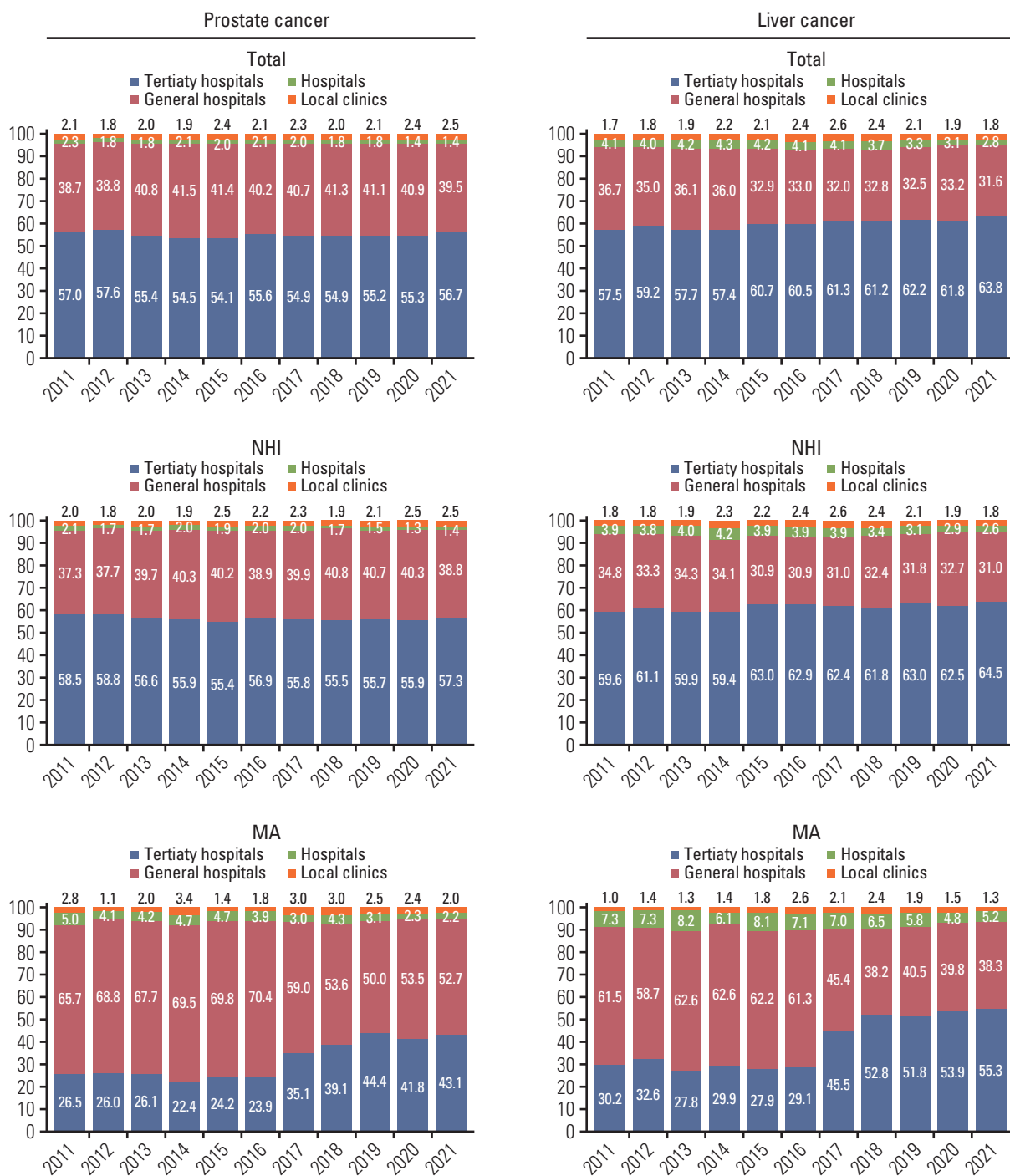


Fig. 3. (Continued from the previous page) (Continued to the next page)

1.88 to 1.93) in 2011 and 2021. Only the OR for thyroid cancer was conversely lower in the MA group, at 0.67 (95% CI, 0.63 to 0.72) and 0.68 (95% CI, 0.63 to 0.73) in 2011 and 2021, respectively. The reason why thyroid cancer tended to be different from other cancers is due to specific characteristic

of thyroid cancer and thyroid cancer patients. Mortality of thyroid cancer is exceptionally low compared to other cancers, and thyroid cancer is known to be more affected by high socioeconomic factors such as income. People with high income tend to use more medical services than people with

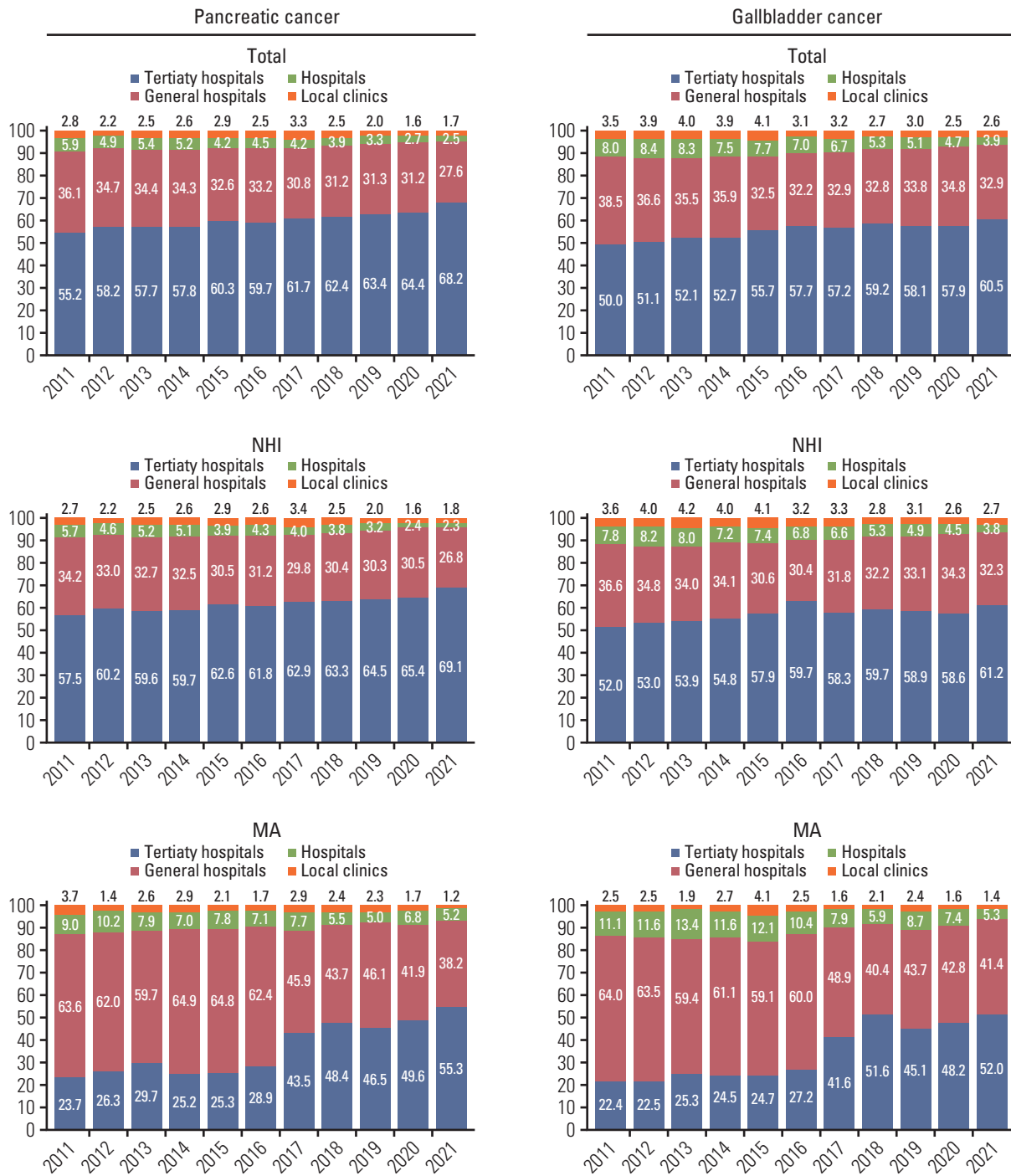


Fig. 3. (Continued from the previous page) (Continued to the next page)

low income and are more at risk of overutilization [16-19]. High-income patients tend to be screened with more sensitive tests, and such tendency may lead to earlier diagnosis, increasing the possibility of overdiagnosis [19-21]. Such characteristics of thyroid cancer patients may have influenced the

results that thyroid cancer has the highest number of patients of all cancers.

Assuming that even within the same region there are differences in the choice of higher level of care for socioeconomic reasons, we analyzed whether there were differences

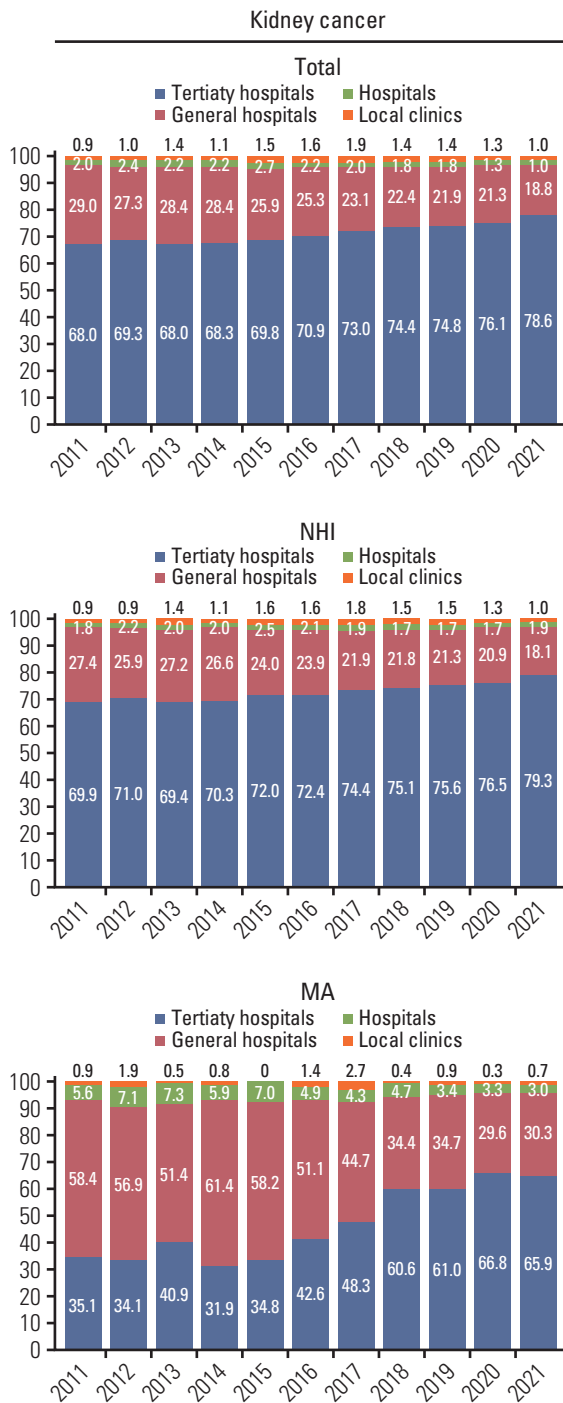


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by type of initial diagnosis. The proportion of the type of hospital where patients were first diagnosed with cancer was different between the NHI and the MA groups. More than 60% of cancer incidence in the NHI beneficiaries was diagnosed at tertiary hospitals and around 30% at general

hospitals. On the other hand, general hospitals were where $\geq 60\%$ of cancer cases of the MA recipients were diagnosed between 2011 and 2016. This represents that the NHI beneficiaries could afford to pay more medical expenses while the MA recipients are financially vulnerable. However, in the MA group, the proportion of cancer diagnosis at tertiary hospitals increased from 28.5% in 2011 to 54.0% in 2021, while the proportion at general hospitals decreased from 61.4% in 2011 to 38.7% in 2021. These changes have been significant since 2017 for most cancers. We could possibly interpret this result as enhanced cancer coverage by the NHI. Under the health insurance coverage enhancement policy implemented since 2017, the upper limit of health insurance deductibles paid by the lowest 50% of income earners was reduced to 10% of their annual income. In addition to expanding rebates for low-income earners, the catastrophic medical expense support program, which covers therapeutic out-of-pocket medical expenses, was expanded from four serious diseases to all diseases, and the maximum amount of support was raised from KRW 20 million to KRW 30 million (USD 15,000 to USD 24,000).

In Korea, when a person is diagnosed with cancer of any type, the NHI covers 95% of medical expenses. Cancer patients pay only 5% of total cancer treatment expenses regardless of their health coverage. Cancer patients burden 5% of treatment expenses from out-of-pocket, therefore we may assume that cancer patients in the MA group feel less burdened by treatment costs, resulting in an increased proportion of tertiary hospitals in the first diagnosis of cancer. Despite an increase in the proportion of the MA patients diagnosed with cancer at tertiary hospitals, it was still about 10% lower than in the NHI group, and disparity still existed.

This study has some limitations. First, we used only cancer incidence as the outcome variable in this study. Health inequity would be ideal if it did not exist. However, unfortunately, inequity exists in the real world. Accurately measuring the magnitude of inequity is important. Therefore, choosing appropriate health inequity indicators is inevitable to measure health inequity. Four perspectives are considered when conducting research regarding cancer: treatment, mortality, screening, and stage. In this study, we could not afford to take cancer treatment, cancer mortality, and stage as outcome variables due to data structure. However, cancer incidence may be appropriate outcome variable in Korea. As stated above, with the low cost of treatment, there would be less reason for newly diagnosed cancer patients not to have medical treatment. Further research would be necessary to evaluate health disparities in cancer using other outcome variables such as treatment, mortality, stage, etc. Second, our results cannot provide information regarding the impact of coronavirus disease 2019 (COVID-19) on cancer patients in

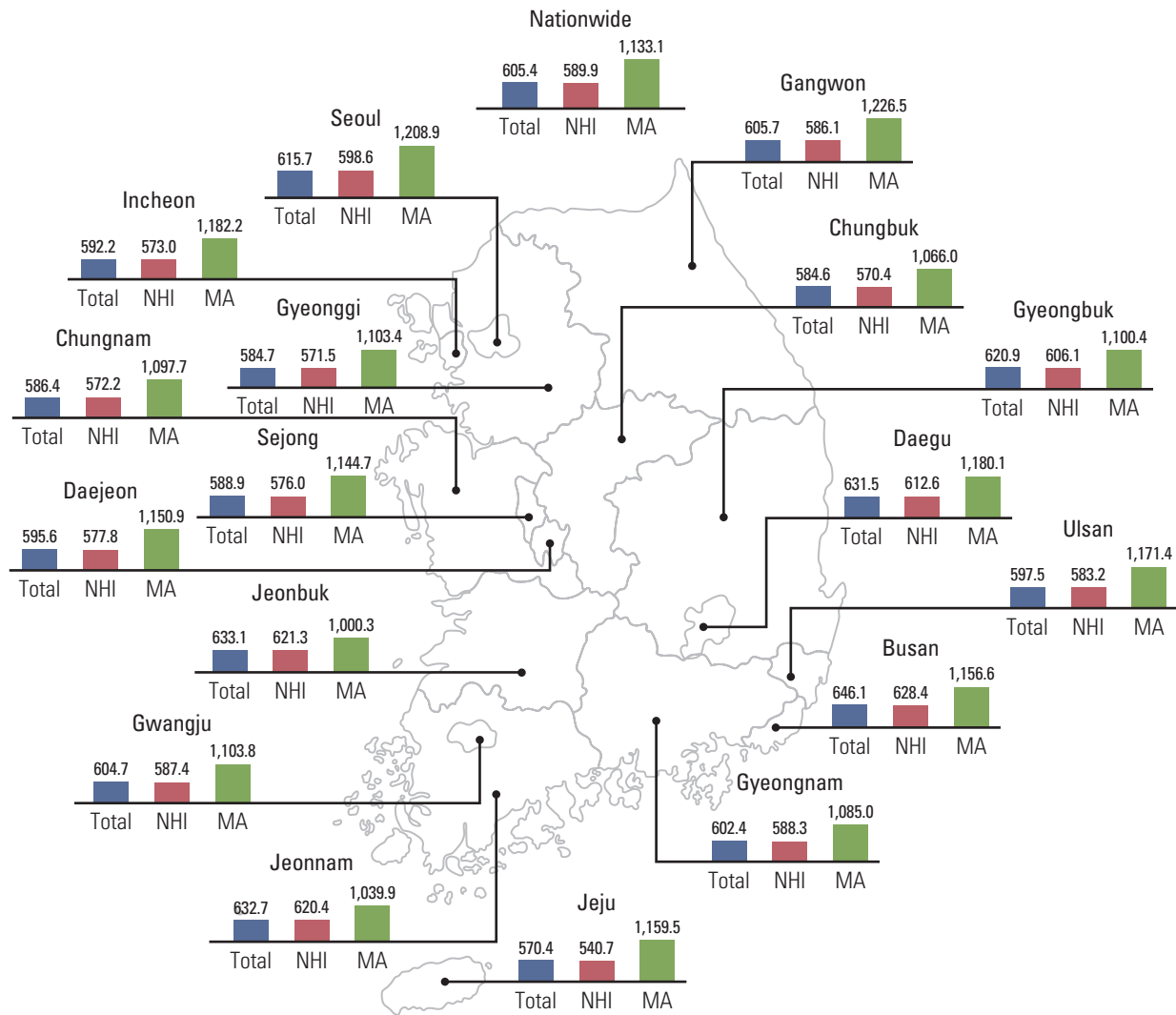


Fig. 4. Age-sex standardized cancer incidence rates by region and insurance type in 2021 (Units: cases per 100,000 population). MA, medical aid; NHI, National Health Insurance.

2020 and 2021. As no conclusive evidence of carcinogenesis of COVID-19 has been established, we ruled out the risk of COVID-19. Third, while it is common to use cancer registry data to study cancer incidence or mortality, we were unable to use a variable for type of health insurance, which is the minimum variable to distinguish the economic level that is the main interest of this study. Instead, we used health insurance claims data, which can be used to manipulatively define new cancers through healthcare use by the total population. By using the primary diagnosis and a special benefit code for cancer, the accuracy of the data can be improved and considered reliable. Seo et al. [22] investigated that cancer incidence rates between the National Cancer Registry and the NHI claims data were very similar, with 363.1 cases per 100,000 population in the NHI claims data and 361.9 cases

per 100,000 population in the National Cancer Registry data from 2005-2008.

In terms of future policy recommendations, it would be ideal if the National Cancer Registry data included an indicator of income. Currently, there are no income indicators in the National Cancer Registry data, so we are forced to use the NHI claims data. If it is not possible to add an income indicator to the National Cancer Registry data, it is essential to cooperate with relevant organizations to link the NHI claims data.

In conclusion, this study investigated that socioeconomic disparities in cancer incidence have worsened by health coverage, region, and over the study period. Nevertheless, increased health coverage may have influenced the proportion of tertiary hospitals in the MA group. Understanding

these disparities is crucial for implementing of public health policies to reduce health inequality.

Electronic Supplementary Material

Supplementary materials are available at Cancer Research and Treatment website (<https://www.e-crt.org>).

Ethical Statement

This study was reviewed and approved by the institutional review board (IRB) of Seoul National University Bundang Hospital (IRB No. X-2304-820-902). Informed consent was waived as we used anonymized data.

Author Contributions

Conceived and designed the analysis: Chang Y, Hwang SH, Lee H, Lee JY.

Collected the data: Hwang SH, Cho SA, Lee JY.

Contributed data or analysis tools: Hwang SH, Cho SA, Lee JY.


Performed the analysis: Hwang SH, Cho SA.

Wrote the paper: Chang Y, Hwang SH.

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Conflicts of Interest

Conflict of interest relevant to this article was not reported.

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